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FORTY-SECOND ANNUAL REPORT

OF THE

New Jersey State Agricultural Experiment Station

AND THE

THIRTY-FOURTH ANNUAL REPORT

OF THE

New Jersey Agricultural College Experiment Station

FOR THE YEAR ENDING JUNE 30

1921

TRENTON, N. J.
PUBLISHED BY THE STATE
1922

New Jersey St. Agr. Exper. Sta.
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*Staff list revised to June 30, 1921.

†On leave of absence.

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DEPARTMENT OF AGRICULTURAL EXTENSION
ORGANIZED 1912

AND

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*On part time.

Letters of Transmittal

To His Excellency, Edward I. Edwards, Governor of the State of New Jersey:

SIR—I have the honor to submit herewith the Forty-second Annual Report of the New Jersey State Agricultural Experiment Station, as required by the law establishing the Station, which was approved March 10, 1880, and which is chapter 106 of the laws of that year.

JAMES NEILSON,
President.

NEW BRUNSWICK, N. J., July 31, 1921.

To His Excellency, Edward I. Edwards, Governor of the State of New Jersey:

SIR—In compliance with an act of Congress, approved March 2, 1887, and with an act of the Legislature of this State, approved March 5, 1888, I beg leave to submit, on behalf of the Trustees of Rutgers College in New Jersey, maintaining Rutgers Scientific School, the New Jersey State College, for the benefit of Agriculture and Mechanic Arts, the Thirty-fourth Annual Report of the operations of the Department of the College which has been organized in accordance with said act of Congress, and is known as "The State Agricultural College Experiment Station."

W. H. S. DEMAREST,
President.

NEW BRUNSWICK, N. J., July 31, 1921.

Treasurer's Report

Irving E. Quackenboss, in account with the New Jersey State Agricultural Experiment Station, July 1st, 1920, to June 30th, 1921.

Appropriation for Salaries, Wages and Maintenance

Appropriation	$60.000.00
Collections from Dairy Department	19,489.00
Collections from Animal Husbandry Department	2,575.96
Collections from Horticulture Department	1,209.50
Refund-Freight Charges on Lime	36.61
	$83,311.07

PAYMENTS

By Treasurer of the Experiment Station—	
Salaries and Wages	$41 383.78
Bills submitted to State Comptroller for direct payment—	
Books and Periodicals	698.65
Coal	1,677.90
Dairy Farm House Furniture and Supplies	126.00
Dues	80.00
Electric Current and Gas	1,712.09
Express, Freight and Cartage	1,582.13
Fair Exhibits and Field Day Expenses	49.45
Feed and Shavings	14.886.33
Fertilizer	449.47
Grading and Construction of Road	3 810.72
Hardware, Tools, etc.	872.79
Insurance	235.85
Laundry Work	253.74
Miscellaneous Hour and Day Labor	2.063.87
Office Furniture and Equipment	747.24
Photographic Supplies	267.00
Postage	581.74
Registration of Animals	35.50
Rent of Fruit Grader	50.00
Repairs and Alterations to Buildings	1,088.61
Repairs to Equipment	815.26
Scientific Equipment	474.54
Scientific Supplies	466.19
Small Printing and Stationery	1,958.52
Telephone and Telegraph	968.18
Traveling Expenses	5,479.45
Trees, Seeds and Vines	50.50

Veterinary Services and Medicine	$116.60
Water and Ice	148.98
Sundries	22.22
	$83,153.30
Amount reverting to State Treasury	157.77
Total	$83,311.07

Appropriation for Printing Bulletins and Circulars

Appropriation	$15,000.00

PAYMENTS

Bills submitted to State Comptroller for direct payment—	
For Printing Bulletins and Circulars	$11,454.69
Amount reserved by requisition until next fiscal year	3,530.75
Amount reverting to State Treasury	14.56
Total	$15,000.00

Appropriation for Abolishing Mosquito Breeding Salt Marshes

Appropriation	$16,500.00

PAYMENTS

By Treasurer of the Experiment Station—	
Salaries and Wages	$6,125.84
Bills submitted to State Comptroller for direct payment—	
Advertising	53.04
Express, Freight and Cartage	25.52
Field Supplies	88.89
Field Work-Ditching Contracts	7,000.00
Materials for Installation of two Sluiceways	450.00
Miscellaneous Hour and Day Labor	319.00
Office Furniture and Equipment	130.25
Photographic Supplies and Blue Prints	64.81
Postage	60.00
Small Printing and Stationery	3.75
Telephone and Telegraph	67.43
Traveling Expenses	2,040.02
	$16,428.55
Amount reverting to State Treasury	71.45
Total	$16,500.00

Appropriation for the Investigation of Oyster Propagation

Appropriation	$1,200.00

PAYMENTS

By Treasurer of the Experiment Station—	
Salaries and Wages	$600.00
Bills submitted to State Comptroller for direct payment—	
Express, Freight and Cartage	9.05
Hardware, Tools, etc.	83.00
Insurance	33.60
Laboratory Equipment	156.34
Overhauling and Repairing Oyster Boats	112.22
Photographic Supplies	22.37
Traveling Expenses	170.16
	$1,186.74
Amount reverting to State Treasury	13.26
Total	$1,200.00

Appropriation for the Department of Poultry Husbandry

Appropriation	$15,000.00
Collections for Sales of Poultry and Eggs	10,830.33
	$25,830.33

PAYMENTS

By Treasurer of the Experiment Station—	
Salaries and Wages	$11,770.00
Bills submitted to State Comptroller for direct payment—	
Books and Periodicals	9.00
Coal	439.65
Dog Cakes	29.00
Insurance	463.30
Miscellaneous Hour and Day Labor	18.14
Office Furniture and Equipment	62.00
Postage	200.00
Poultry Feed	9,920.83
Poultry Stock	400.00
Poultry Supplies and Tools	907.66
Repairs and Alterations to Buildings and Fences	472.43
Scientific Equipment	314.02
Scientific Supplies	26.00
Small Printing and Stationery	36.53
Traveling Expenses	713.33
	$25,781.89
Amount reverting to State Treasury	48.44
Total	$25,830.33

Appropriation for Seed Inspection

Appropriation	$7,500.00

PAYMENTS

By Treasurer of the Experiment Station—	
Salaries and Wages	$5,300.00
Bills submitted to State Comptroller for direct payment—	
Dues	5.00
Gasoline Pump and Tank	225.00
Miscellaneous Hour and Day Labor	8.40
Office Furniture and Equipment	8.67
Postage	470.15
Scientific Equipment	3.70
Scientific Supplies	68.10
Small Printing and Stationery	252.35
Telephone and Telegraph	1.77
Traveling Expenses	1,049.10
Seeds	6.34
	$7,398.58
Amount reverting to State Treasury	101.42
Total	$7,500.00

Appropriation for Experimental Work in Vegetable Production

Appropriation	$2,500.00
Collections for Sales of Vegetables	1,816.27
Collections for Sales of Flowers	650.34
	$4,966.61

PAYMENTS

By Treasurer of the Experiment Station—	
Salaries and Wages	$2,596.00
Bills submitted to State Comptroller for direct payment—	
Coal	612.50
Fertilizer	46.63
Greenhouse Supplies and Tools	230.73
Insurance	109.70
Miscellaneous Hour and Day Labor	597.53
Repairs and Alterations to Buildings	427.02
Scientific Equipment	127.65
Scientific Supplies	135.60
Seeds	25.47
	$4,908.83
Amount reverting to State Treasury	57.78
Total	$4,966.61

Appropriation for Insecticide Inspection

Appropriation	$1,000.00

PAYMENTS

Bills submitted to State Comptroller for direct payment—	
Scientific Equipment	$278.60
Scientific Supplies	707.36
	$985.96
Amount reverting to State Treasury	14.04
Total	$1,000.00

Appropriation for Farm Demonstration

Appropriation	$65.000.00

PAYMENTS

By Treasurer of the Experiment Station—	
Salaries and Wages	$59.196.14
Bills submitted to State Comptroller for direct payment—	
Automobile Truck	1.725.00
Coal	250.00
Dues	5.00
Office Furniture and Equipment	4.75
Photographic Supplies	2.58
Postage	893.03
Printing Circulars	2,046.99
Telephone and Telegraph	1.45
Traveling Expenses	875.06
Total	$65,000.00

Appropriation for Cranberry Investigation

Appropriation	$5,000.00

PAYMENTS

By Treasurer of the Experiment Station—	
Salaries and Wages	$3.100.00

Bills submitted to State Comptroller for direct payment—

Express, Freight and Cartage	$52.49
Fertilizer	17.87
Field Supplies	53.25
Miscellaneous Hour and Day Labor	195.95
Office Furniture and Equipment	346.29
Photographic Supplies	2.80
Postage	1.00
Scientific Equipment	282.45
Scientific Supplies	80.86
Small Printing and Stationery	12.15
Telephone and Telegraph	6.35
Traveling Expenses	838.51
	$4,989.97
Amount reverting to State Treasury	10.03
Total	$5,000.00

Appropriation for Vineland Egg-Laying and Breeding Tests

Appropriation	$5.000.00

PAYMENTS

By Treasurer of the Experiment Station—

Salaries and Wages	$2,756.66

Bills submitted to State Comptroller for direct payment—

Feed	2,191.75
Traveling Expenses	45.19
	$4,993.60
Amount reverting to State Treasury	6.40
Total	$5,000.00

Appropriation for Experimental Work in Growing White Potatoes, Sweet Potatoes and Tomatoes

Appropriation	$8,000.00

PAYMENTS

By Treasurer of the Experiment Station—

Salaries and Wages	$4,640.00

Bills submitted to State Comptroller for direct payment—	
Express, Freight and Cartage	$14.83
Field Supplies	156.81
Miscellaneous Hour and Day Labor	305.08
Photographic Supplies	82.11
Rental and Management of Sweet Potato Beds	100.00
Scientific Equipment	265.64
Scientific Supplies	35.00
Telephone and Telegraph	14.45
Traveling Expenses	2,233.31
Seeds	46.05
	$7,893.28
Amount reverting to State Treasury	106.72
Total	$8,000.00

Appropriation for Repairs to the Experiment Station Building

Appropriation	$1,000.00

PAYMENTS

Bills submitted to State Comptroller for direct payment—	
Repairs to Experiment Station Building	$999.20
Amount reverting to State Treasury	.80
Total	$1,000.00

Appropriation for Legume Inoculation Inspection

Appropriation	$2.000.00

PAYMENTS

By Treasurer of the Experiment Station—	
Salaries and Wages	$1,400.00
Bills submitted to State Comptroller for direct payment—	
Office Furniture and Equipment	18.30
Legume Inoculent Samples	51.60
Scientific Equipment	160.44
Scientific Supplies	52.90
Traveling Expenses	78.68
	$1,761.92
Amount reserved by requisition until next fiscal year	216.97
Amount reverting to State Treasury	21.11
Total	$2,000.00

Appropriation for Materials for Lean To

Appropriation	$1,000.00

PAYMENTS

Bills submitted to State Comptroller for direct payment—	
Erection of a Lean To	$996.00
Amount reverting to State Treasury	4.00
Total	$1,000.00

Appropriation for Poultry Exhibitions

Appropriation	$4,000.00

PAYMENTS

By Treasurer of the Experiment Station—	
Salaries and Wages	$795.00
Bills submitted to State Comptroller for direct payment—	
Premiums Awarded	2,434.50
Small Printing and Stationery	5.52
Supplies and Materials used for Exhibits	247.64
Traveling Expenses	499.17
	$3,981.83
Amount reverting to State Treasury	18.17
Total	$4,000.00

Appropriation for Bergen County Egg-Laying Contest

Appropriation	$5 000.00

PAYMENTS

By Treasurer of the Experiment Station—	
Salaries and Wages	$3,720.00
Bills submitted to State Comptroller for direct payment—	
Feed	1,207.00
Traveling Expenses	49.00
	$4,976.00
Amount reverting to State Treasury	24.00
Total	$5,000.00

Appropriation for Milk and Cream Inspection

Appropriation	$3,000.00
Collections for Testing Glassware and Testers' Licenses Issued	484.62
	$3,484.62

PAYMENTS

By Treasurer of the Experiment Station—	
Salaries and Wages	$1,998.00
Bills submitted to State Comptroller for direct payment—	
Hardware, Tools, etc.	108.13
Scientific Equipment	116.25
Small Printing and Stationery	67.85
Traveling Expenses	1.120.18
Sundries	2.10
	$3,412.51
Amount reverting to State Treasury	72.11
Total	$3,484.62

Feed Inspection Fees

Appropriation-Collection of Feed Inspection Fees	$21,577.60

PAYMENTS

By Treasurer of the Experiment Station—	
Salaries and Wages	$5,170.04
Bills submitted to State Comptroller for direct payment—	
Books and Periodicals	24.65
Coal	70.00
Electric Current and Gas	735.13
Express, Freight and Cartage	388.22
Feed and Shavings	7,368.47
Fertilizer	1,352.68
Grading and Construction of Road	698.69
Hardware, Tools, etc.	471.74
Insurance	112.00
Laundry Work	35.00
Miscellaneous Hour and Day Labor	147.33
Office Furniture and Equipment	164.31
Photographic Supplies	58.13
Postage	301.81
Repairs and Alterations to Buildings	371.59
Repairs to Equipment	213.84
Scientific Equipment	121.76
Scientific Supplies	587.46
Small Printing and Stationery	108.61

Telephone and Telegraph	$493.62
Traveling Expenses	1,517.17
Trees, Seeds and Vines	539.29
Veterinary Services and Medicine	171.78
Water and Ice	42.50
Sundries	17.64
	$21,283.46
Amount reverting to State Treasury	294.14
Total	$21,577.60

Fertilizer Inspection Fees

Appropriation-Collections of Fertilizer Inspection Fees	$28,437.45

PAYMENTS

By Treasurer of the Experiment Station—	
Salaries and Wages	$21,833.02
Bills submitted to State Comptroller for direct payment—	
Dairy Farm House Furniture	50.00
Fair Exhibits and Field Day Expenses	395.15
Feed and Shavings	1,769.00
Ford Cars (2)	1,135.00
Grading and Construction of Road	875.00
Hardware, Tools, etc.	99.03
Miscellaneous Hour and Day Labor	810.64
Office Furniture and Equipment	55.10
Postage	75.00
Repairs and Alterations to Buildings	191.97
Small Printing and Stationery	58.13
Telephone and Telegraph	697.72
	$28,044.76
Amount reserved by requisition until next fiscal year	291.69
Amount reverting to State Treasury	101.00
Total	$28.437.45

Bonus Account

Experiment Station Share of Appropriation	$5,882.40

PAYMENTS

By Treasurer of the Experiment Station—	
Bonus to Employees covering Last Half of Bonus for the year 1919–1920	$5,882.40

SUMMARY

Total Appropriations	$217,700.00
Total Collections Credited to Appropriations	87,107.68
Experiment Station Share of Bonus Appropriation	5,882.40
Total	$310,690.08

Summary of Analysis of all Expenditures

Advertising	$53.04
Automobiles	3,860.00
Books and Periodicals	732.30
Coal	3,050.05
Dairy Farm House Furniture and Supplies	176.00
Dues	90.00
Electric Current and Gas	2,447.22
Erection of a Lean To	996.00
Express, Freight and Cartage	2,072.24
Fair Exhibits and Field Day Expenses	692.24
Feed and Shavings	37,372.38
Fertilizer	1,866.65
Field Supplies	298.95
Gasoline Pump and Tank	225.00
Grading and Construction of Road	5,384.41
Hardware, Tools, etc.	2,773.08
Insurance	954.45
Laundry Work	288.74
Materials for Installation of Two Sluiceways for Mosquito Drainage,	450.00
Mosquito Field Work-Ditching Contracts	7,000.00
Miscellaneous Hour and Day Labor	4,465.94
Office Furniture and Equipment	1,536.91
Photographic Supplies and Blue Prints.	499.80
Postage	2,582.73
Poultry Stock	400.00
Premiums for Poultry Exhibitions	2,434.50
Printing Bulletins and Circulars	13,501.68
Registration of Animals	35.50
Rent of Fruit Grader	50.00
Rental and Management of Sweet Potato Beds	100.00
Repairs and Alterations to Buildings and Fences	3,550.82
Repairs to Equipment	1,141.32
Salaries and Wages	172,384.48
Scientific Equipment	2,301.39
Scientific Supplies	2,211.07
Small Printing and Stationery	2,503.41
Telephone and Telegraph	2,250.97
Traveling Expenses	16,708.33
Trees, Seeds and Vines	667.65
Veterinary Services and Medicine	288.38

Water and Ice	$191.48
Sundries	41.96
Bonus to Employees covering Last Half of Bonus year 1919–1920	5,882.40
	$305,513.47
Amount reserved by requisition until next fiscal year	4,039.41
Amount reverting to State Treasury	1,137.20
Total	$310.690.08

Collections Account

RECEIPTS

From Dairy Department—	
Collections for Sales of Milk, Cream and Dairy Stock	$19.489.00
From Animal Husbandry Department—	
Collections for Sales of Swine	2.575.96
From Horticulture Department—	
Collections for Sales of Second Hand Orchard Equipment and Supplies	1,209.50
From Raritan River Railroad Co.—	
Refund-Freight Charges on Lime	36.61
From Poultry Department—	
Collections for Sales of Poultry and Eggs	10,830.33
From Vegetable Gardening Department—	
Collections for Sales of Vegetables	1.816.27
From Floriculture Department—	
Collections for Sales of Flowers	650.34
From Dairy Department—	
Collections for Testing Glassware and Testers' Licenses Issued.	484.62
From Chemical Department—	
Collection of Feed Inspection and Registration Fees	21,577.60
From Chemical Department —	
Collection of Fertilizer Inspection and Registration Fees	28,437.45
From National Bank of New Jersey—	
For Interest on Deposits	112.32
Total	$87.220.00

PAYMENTS

To State Treasurer— Collections for Sales of Milk, Cream and Dairy Stock	$19,489.00
To State Treasurer— Collections for Sales of Swine	2,575.96
To State Treasurer— Collections for Sales of Second Hand Orchard Equipment and Supplies	1,209.50
To State Treasurer— Refund-Freight Charges on Lime	36.61
To State Treasurer— Collections for Sales of Poultry and Eggs	10,830.33
To State Treasurer— Collections for Sales of Vegetables	1,816.27
To State Treasurer— Collections for Sales of Flowers	650.34
To State Treasurer— Collections for Testing Glassware and Testers' Licenses Issued,	484.62
To State Treasurer— Collection of Feed Inspection and Registration Fees	21,577.60
To State Treasurer— Collection of Fertilizer Inspection and Registration Fees	28,437.45
To State Treasurer— For Interest on Deposits	112.32
Total	$87,220.00

The Auditing Committee of the Experiment Station has examined the Accounts of the Treasurer of said Station, and has found them correct.

(Signed) WM. H. REID,
EGBERT T. BUSH,
Auditing Committee.

Financial Statement

TRUSTEES OF RUTGERS COLLEGE FOR THE NEW JERSEY STATE AGRICULTURAL COLLEGE EXPERIMENT STATION IN ACCOUNT WITH THE UNITED STATES APPROPRIATION, 1920–1921

Dr.	*Hatch Fund*	*Adams Fund*
To Receipts from the Treasurer of the United States as per Appropriations for Fiscal Year Ended June 30th, 1921, Under Acts of Congress Approved March 2d, 1887 (Hatch Fund), and March 16th, 1906 (Adams Fund)	$15,000.00	$15,000.00

Abstracts	*Hatch*	*Adams*
Salaries	$9,162.93	$11,581.70
Labor	1.303.11	727.58
Publications	504.98	....
Postage and Stationery	265.27	34.64
Freight and Express	40.20	1.00
Heat, Light, Water and Power	91.22	273.33
Chemicals and Laboratory Supplies	907.81	542.21
Seeds, Plants, etc.	610.64	312.53
Fertilizers	8.30	8.87
Feeding Stuffs	....	360.00
Library	82.69	88.40
Tools, Machinery, etc.	60.62	475.71
Furniture and Fixtures	104.15	140.11
Scientific Apparatus	34.58	38.80
Traveling Expenses	1,683.32	8.94
Contingent Expenses	10.20	....
Buildings and Land	129.98	406.18
	$15.000.00	$15,000.00

REPORT OF THE DIRECTOR

Report of the Director

JACOB G. LIPMAN, PH.D., *Director*

LINDLEY G. COOK, B.SC., *Assistant to the Director*

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Report of the Director

JACOB G. LIPMAN

INTRODUCTION

It is proper to review from time to time the more important changes that occur in the agriculture of the state. The returns of the Fourteenth Census offer an opportunity to consider the trend of farming in New Jersey as indicated by the comparative data of the census of 1910 and of 1920, respectively.

It is shown by the returns of the Fourteenth Census that the tendency so manifest during the first ten years of the present century toward a shrinkage in the number of farms as well as a reduction in the area of cultivated land has been hardly less marked in the following ten years. One is almost forced to conclude that, in spite of the nearness of the markets and the excellent transportation facilities, the competition of the city industries and the many opportunities for attractive employment of a non-agricultural character have drawn a portion of our rural population away from the farm. The recent census figures show that the number of farms in the state and the area of farm land have decreased by about 11 per cent and that the improved land in farms has decreased by nearly 14 per cent. Most of the shrinkage has occurred in the northern part of the state, which is really included in the metropolitan district. The most striking reduction in the number of farms has occurred in Bergen, Essex, Hudson, Morris, Passaic and Union counties. In one of the counties, namely, Hudson, there were in 1920 only 98 farms, whereas ten years before there were 215 farms. The number of farms reported for Essex was 375 in 1920, 633 in 1910 and 1,003 in 1900. There is no doubt that this tendency will continue in certain sections of the state, thanks largely to the encroachment of our cities, the development of suburban homes and the establishment of new industries. In some of the South Jersey counties, on the other hand, there has been a more or less marked increase in the number of farms. This is notable particularly in the case of Atlantic and Cumberland counties.

The reduction in the acreage of cultivated land and in the number of farms is offset to a large degree by the more intensive practices and the greater degree of specialization among the farmers in the state. In some directions the specialization has been proceeding very fast. There has been a very large increase in the acreage of potatoes, of apples and peaches, and intensification in the production of eggs and market milk. The number of commercial poultry plants has increased, while the production of eggs per hen and yield of milk per cow have also shown very marked increases. Because of the inflated value of all commodities, there has been a significant increase in the value of farm property, including land, buildings, equipment and livestock. The census figures show that this increase for the period 1910-1920 was equivalent to nearly 22.5 per cent. This has been a more or less general tendency in all of the rural territory of the United States.

The lessons to be drawn from the Census of 1920 are encouraging, at least to the extent that they show intensification in production and larger returns per acre and per animal. They also show that the progressive farmers are specializing to a greater extent than heretofore in the growing of crops possessing relatively high commercial value. Much of the land in southern New Jersey heretofore regarded as very unpromising is being taken up by Italian and other immigrant farmers and developed as sites of peach, pear and apple orchards, of vineyards and of plantations of small fruits.

The tendencies and changes in the agricultural practices of the state just noted are creating certain responsibilities and problems for the Experiment Station. Because of the more intensive practices, and the more frequent growing of the same crop, insect and fungus enemies become more troublesome. Soil fertility problems become more complicated. As a result of this condition, insistent requests come to the station for searching study of questions that have become troublesome. Thus, the potato growers of the state have appealed to the station for the study of certain fertilizer questions relating to potato production, the study of fungus diseases and particularly possible methods for the control of the potato scab, and the searching for varieties better suited than those now grown for the New Jersey conditions, or methods of producing seed potatoes that would assure the grower of more certain returns. Similarly, in the case of sweet potatoes it has become necessary, through the urging of the growers, to make a special study of methods of controlling stem rot and other diseases. The cranberry growers have placed at the disposal of the Experiment Station suitable facilities at Whitesbog where extensive experiments on fertilizers, diseases, insects, water supply, etc., are being carried on. Spraying and dusting experiments with apples and pears, dusting, fertilizer and variety experiments with vegetables, egg-laying contests, etc., are in progress. Aside from important investigations of a more or less permanent character in different localities of the state there are scores of experiments of a more local or temporary nature in progress in practically every agricultural county. These are entirely aside from the investigations in progress at New Brunswick. Thanks to the intimate contact of our county agents with the farm constituency, many problems are uncovered and brought to the station and requests made for the study of these problems.

There are certain advantages in the carrying on of investigations in different localities of the state. Because of differences in soil and climatic conditions certain studies cannot be carried on at New Brunswick. This applies particularly to the improvement of the very light sandy soils by means of green manures, the fertilization of cranberries and blueberries, the growing of sweet potatoes, the study of oyster propagation, the control of the diseases of celery, etc. Members of the staff in charge of these outlying experiments lose a certain amount of time in going back and forth; they gain, on the other hand, through their contact with field conditions and their better understanding of the local problems. There is a gain to the farmers themselves, in that they are able to watch the progress of the investigations under their own conditions. In a small state like New Jersey outside investigations are more easy to carry on than they would be in larger states where the distances are greater. That the farmers in New Jersey have benefited by the many investigations, demonstration experiments and tests in progress all over the state is clear from the improved methods of practice and the improved yields.

More than one hundred research projects are now being carried on by the departments of the Experiment Station. A list of these projects is given elsewhere in this report. It may be pointed out at this time that the investigations outlined in these projects attempt to deal with the more pressing problems of New Jersey agriculture, even though they do not overlook the fundamental values involved. For this reason, the data which have already been secured and which are to be secured in the conduct of these investigations are of more than local value and apply to conditions in other states and in other countries. The investigational work of the station has gained in strength by the appointing of research committees by a number of the producing associations in the state. The State Potato Growers' Association, the State Poultry Association, the State Horticultural Society and the American Cranberry Growers' Association all have research committees that keep in touch with the investigational work in their respective fields. Not only are the members of the staff helped by the advice and suggestions of the members of the research committees, but the latter also benefit, in that they can speak in a more authoritative way of the problems that are of peculiar interest to members of their associations.

Contact with the farmers in the state is maintained in many ways. The extension division of the college and station is at all times in touch with a large constituency through the county agents, home demonstration agents, club leaders, extension specialists and local leaders. Members of the station and agricultural college staff frequently attend farmers' meetings, while large numbers of farmers come to New Brunswick, especially during the Field Day and other meetings. The attendance at the meetings of the State Horticultural Society at Atlantic City, and of the State Potato Growers' Association, State Poultry Association, breeders' associations, etc., held in connection with the meetings of the State Board of Agriculture in Trenton, is usually very large, and many opportunities are thus offered to members of the staff to gain the point of view of the producers as well as to acquaint the latter with the activities of their institution.

The pronounced tendency among the farmers in the United States to strengthen their organization and to effect a greater degree of cooperation in the marketing of their products has been as evident in New Jersey as it has elsewhere. The county boards of agriculture and producers' associations have accomplished much within the past year in strengthening their organizations and in impressing the farmers with the urgent need for greater unity of action. It is realized by the producers themselves that agriculture in the state is not only changing but that it will continue to change; and that the industry itself will survive and flourish only in so far as economical production can be maintained. This necessarily means the obtaining of raw materials, such as seed, fertilizer, feeding stuffs, farm machinery, etc., at the lowest possible cost; the elimination of all waste in production, particularly the control of injurious insects and diseases; the improving of the quality of the products; the standardization of these products and collective bargaining in the marketing of farm crops. While this condition is not at all peculiar to New Jersey, the farmers in the state are beginning to recognize that lower production costs and higher relative returns are an essential feature of successful farming, and that these alone will assure the agricultural future of New Jersey. But where a program of this sort is attempted research and education are bound to play a prominent part. Hence, the Experiment Station and State Agricultural College share with other agricultural organizations the responsibility in helping to point the way to economical production and to more effective methods of marketing farm crops.

BUILDINGS AND EQUIPMENT

The Experiment Station is receiving the generous support of the State Agricultural College in many directions. The buildings and land of the Agricultural College are in part available for use by the station. Thanks to the completion of the central portion of the Horticultural Building, the Experiment Station has been enabled through the courtesy of the college to extend its office and laboratory facilities in horticulture. When the Horticultural Building is ultimately completed the horticultural department of the station should be sufficiently well provided for in a physical way for uninterrupted progress in all of the branches of the service with which it is concerned. The outlook for the horticultural department has been still further improved by the granting of an appropriation to the College of $5,000 to be expended in the construction of a horticultural storage and laboratory building to be used for the preparation of spray and dust mixtures, the testing of spraying and dusting machinery, as well as the testing of other horticultural tools.

The Legislature has also appropriated the sum of $85,000 for the erection of an educational poultry building. This building, which should be completed in the early summer of 1922, will help the poultry department of the station in the study of the problems that call for modern laboratory equipment. It is expected that provision will be made to establish and suitably equip a poultry research laboratory, so urgently needed for the study of chicken pox and of other diseases of poultry now very troublesome to the poultrymen of the state.

It is expected further that one or two small buildings will be erected within the summer of 1921 to take care of farm machinery and other equipment. The farm mechanics department of the college is badly handicapped by lack of appropriate space for the housing of tractors, trucks and miscellaneous tillage machinery. This is also true of the Experiment Station. The agronomy department of the station has no suitable facilities for the storing of crop samples, seeds and implements, while the animal husbandry department is in need of additional and more modern facilities for experimental work in pork production. These needs, it is hoped, will be met in part by the minor buildings to be constructed in the near future.

The 1921 budget of the college and station will permit the equipping of a dairy chemistry and bacteriological laboratory and the extension of the agricultural library. Both will be of distinct advantage to members of the station staff.

Mention may be made here also of the continued improvement of the dairy herd. The number of pure-bred animals, representing five dairy breeds, has increased to a point where the college and station herd is, indeed, very creditable to both institutions. The foundation herds of Jerseys and Holsteins contain some choice individuals, while the Shorthorns, Guernseys and Ayrshires have improved as to both numbers and quality of the individuals.

IMPROVEMENT OF THE COLLEGE FARM GROUNDS

Plans are well in hand for the development of an agricultural campus. The completion of a portion of the horticultural building, the expected erection of the poultry building and the construction in the future of animal husbandry, farm mechanics, general science and other buildings should strengthen the activities of both the agricultural college and the station. More or less progress has been made in the grading of the agricultural campus, the building of roads and the developing of the ornamental plantings. A program, which has been carefully prepared by members of the college and station staff, points the way to the systematic development of the physical equipment of the college and station. The generous support of this program will be forthcoming, it is hoped, to the end that the teaching, the research and the extension activities of the institutions concerned may be maintained as creditably in the future as they have been in the past.

THE PERSONNEL

There has been no slackening of the activities of the several departments of the station during the fiscal year just passed. The members of the staff have manifested their usual loyalty and earnestness in the performing of the tasks allotted to them. There has been a fine spirit of cooperation among the members of the staff. Meetings of the Station Council are held usually in the forenoon of the first Saturday of each month. At these meetings matters pertaining to the organization of the station service and the conduct of the experimental work are discussed. This allows the members of the staff to become acquainted more intimately with the activities of the institution as a whole.

In spite of the fact that the extension division of the college and station is splendidly organized and is rendering constant and satisfactory service, the members of the research and teaching staff are frequently called upon by farmers' organizations and by individual farmers for advice on many specific matters. In a sense, then, the members of the research and teaching staff must do a certain amount of extension work. This service is rendered willingly and with due consideration for the interests of the investigational and resident teaching work.

The correspondence of the station continues to be very large and growing from year to year. It has been necessary to make substantial additions to the clerical force in order that the letters received from our constituents may receive prompt consideration. With conditions approaching normal, there have been relatively few changes in the staff, at least in so far as the more important positions are concerned.

Resumés of the activities of the several departments, as prepared by the departments, are herewith given.

CHEMISTRY

The activities of the chemistry department during the past year consisted of the inspection work as required by the laws regulating the sale of insecticides, fertilizers, agricultural lime and feeding stuffs. The inspections were completed in accordance with the schedule, and involved the analyses of 1,980 samples. The detailed results obtained by these analyses were duly reported to the parties interested as the work was completed and the results also were published in Bulletins 343, 344, 349, 350 and 354.

Inspection of Insecticides for 1920

During the year 49 manufacturers and dealers registered 266 brands which they were to offer for sale. The chemical work for this inspection included the analyses of 93 samples.

The percentage of deficient samples was small and the materials were of about the same character as reported for previous inspections.

Inspections of Commercial Fertilizers for 1921

Registrations were made by 124 manufacturers and jobbers of 1,572 brands of mixed fertilizers and fertilizer materials.

The inspectors visited every county in the state and secured samples from 437 dealers and consumers. Every brand received at the station was examined and duly reported and in certain instances duplicate samples were examined. The total number of samples examined was 898.

Five hundred and twelve brands of mixed fertilizers were examined; over 73 per cent of these samples containing nitrogen, phosphoric acid and potash, and the others containing nitrogen and phosphoric acid. There were 172, or 33 per cent, of the brands deficient in one or more of the plant-food constituents. The deficiencies consisted of: nitrogen 104, phosphoric acid 61, and potash 31. The percentage of deficient brands is the largest that has been reported since 1912, with the exception of those reported for the year 1916.

Inspection of Agricultural Lime for 1920

During the year 33 manufacturers registered 80 different brands of agricultural lime. A comparatively large number of samples of the lime products were received and duly reported. Several of the samples examined, however, were unofficial samples and the results have not been tabulated in the bulletin with the analyses of the 13 official samples.

On account of the character and variability of the lime products, more attention should be given to the composition of the materials offered for sale.

Inspection of Commercial Feeding Stuffs for 1920

Registrations were received from 428 manufacturers and jobbers for 2,190 brands.

During the inspection, the inspectors secured samples from 260 dealers and consumers. There were examined at the station 876 of the official samples for their content of protein, fat and fiber, and microscopical examinations were made for the purpose of determining the nature of the ingredients used in the preparation of the mixtures.

Thirteen of the official samples were not accompanied by the required guarantees and in each instance the party holding the material was notified of the necessity of furnishing the information before sales were made. The results of the examination of the 863 guaranteed samples show that 133, or 15.4 per cent, were deficient in protein, fat or fiber. The deficiencies found consisted of the following: protein 68, fat 60, and fiber 28.

The results of the inspection, taken as a whole, are the best that have been reported for several years.

HORTICULTURE

Pomology

Apple Pruning Experiment

The trees in the apple-pruning experiment produced only a moderate crop of fruit, on account of a very severe wind and hail storm on June 29, 1920. The unpruned trees again produced the largest number of apples with the "thinned but not cut back" trees second and the "thinned and cut back" third. The fruit on the unpruned trees was smaller, poorer in color and more severely injured by curculio and codling moth than the fruit on the pruned trees. The "thinned out and cut back" trees again made the greatest amount of twig growth, resulting in a very thick top with large but poorly colored fruit. Judging from the general condition of the trees, together with the quality and amount of fruit produced, the "thinned but not cut back" treatment has produced the best results to date.

Apple Measurements

The amount of growth made each week throughout the season by 10 varieties of apples was measured to determine the rate of growth during the various stages in the development of apples, and the influence of temperature and moisture upon the growth of the fruit, as well as the possible relation between the growth of the fruit and spraying recommendations for the control of curculio. These measurements are expected also to form the basis for later experiments on the thinning and fertilization of apples.

Peach Breeding

Peach breeding has been the outstanding feature of the fruit investigations in New Jersey since the discontinuing of the experimental orchard at Vineland. During the season of 1920, 1,700 seedlings fruited and were described for the first time.

It was indicated by the crop of 1919 that 66 individual trees were sufficiently promising to justify their further study and a few trees, therefore, were propagated from each of these individuals. Four of these showed such distinct promise that a large number of nursery trees are being propagated, as is the case with the others. Should they maintain their prominence in 1921 there will be an attempt made to distribute a limited number of trees among the peach growers of the state. On the basis of the results obtained in 1920, the 66 were reduced to 43 possessing special merit, and a few trees of each of the 43 were planted in orchard form on the horticultural farm.

Of the seedlings which fruited first in 1920, 24 were selected as worthy of further trial and a few trees have been propagated for planting in orchard form. The number of new crosses made in 1920 was rather limited. Eighty-four trees were secured from known parents, and in addition 610 seedlings were obtained from open-pollinated trees.

Variety Orchard of Peaches

In connection with the breeding work a special effort is being made to assemble a collection of the leading commercial varieties of peaches in order better to compare and judge the merits of the new seedlings and to provide breeding material. To this collection also are being added varieties and species of peaches introduced from China, Spain and New Zealand by the office of Foreign Seed and Plant Introduction, of the United States Department of Agriculture. To the rather large list of commercial types of peaches there has been added also a collection of ornamental flowers and a few nectarines, almonds and apricots.

Work With Vegetables

The principal feature of the work of the vegetable department for 1920-21 consisted of four extensive fertilizer experiments on tomatoes; two at New Brunswick, with 40 mixtures; one at Masonville on the farm of N. B. Jones with 20 distinct fertilizer treatments, including a comparison of spotted and seedling plants, and one at Cedarville on the farm of H. M. Shepard with 20 distinct fertilizer treatments.

The fertilizer investigations were extended to sweet potatoes in 1921. Two projects were started in early spring which include a triangle test at Toms River and a comparison of different amounts per acre at Pleasantville.

A cabbage-maggot control demonstration and experiment put on at New Brunswick with the following materials gave very marked results over the untreated rows: corrosive sublimate, tar-paper discs and tar and sand. The materials are mentioned in order of their efficiency. The results and methods of application will be published in circular form at a later date.

In 1916 seed selection and improvement work with sweet-corn seed was begun on the variety Howling Mob. For the first 3 years the seed ears were so lacking in uniformity as to shape, grain, etc., that no attempt was made to grade them until this past winter when enough improvement appeared to have been made to warrant careful grading. Five grades were established and the crop was sorted accordingly. The data obtained will furnish a basis by which to measure progress from now on. These sweet-corn investigations also have been extended to include a number of individual ear studies to determine the relation and source of certain undesirable characteristics.

A comparison of 10 Bonny Best tomato seed stocks produced in New Jersey is being made this year. Samples of cannery run, canhouse and special-stock seed were secured from the various sources recorded in the report of the department of horticulture, and planted on the vegetable plots.

Breeding work with tomatoes has also been started and seven crosses are being fruited for the first time this season.

Floriculture

Investigational work in floriculture has been largely confined to carnation breeding. During the past season, 144 new seedlings from crosses were propagated and grown, making a total of more than 3,000 seedlings tested since the work was started in 1911. About 70 seedlings which have been secured from breeding work are grown for testing and further breeding in addition to the new seedlings. Considerable progress has been made toward the securing of a desirable red variety. A number of the new seedlings appeared superior to those of previous years. Two purple carnations were secured in 1917, and since then 8 others have appeared. Several of the latter are superior to the first two. Studies in color inheritance are still being conducted. There are under test one white single in the third generation, several purple seedlings of the second generation and four red seedlings of the second and of the third generations which have come true to color. While the work has been carried on in a rather modest way in the Short Course greenhouses, the progress has been encouraging.

ANIMAL HUSBANDRY

The department of animal husbandry has conducted two experiments during the year and devoted the rest of its activity in the development of the herd and making the change from the quarters the swine have occupied to a new location.

The first of the experiments involved the determination of the efficiency and economy of some of the buttermilk products sold in the state as supplements to ordinary grain feeds and tankage. Forty pigs were used in the trial that continued from July 16, 1920, to October 24, 1920. Daily records were maintained of the amounts of food consumed and three lots of pigs receiving buttermilk products were compared with a lot fed a standard ration of corn, middlings and tankage.

The second experiment with 30 fall pigs consisted of the determination of the effect of pumpkins, with and without seeds, on the growth of the animals. The work, which was conducted by a senior student in advanced nutrition, was compared with work done by him in studying the effect of pumpkin seeds on the human metabolism.

Progress has been made in the improvement of the herd of Duroc-Jersey swine through the system of line-breeding that has been established.

POULTRY HUSBANDRY

During the past year, the Bergen County Egg-Laying and Breed-Testing Station has been built and put into operation with every pen of the entire one hundred filled. At the present writing, this contest is making a very high production and gives promise of setting some new records for the summer months. The contest, as a whole, furnishes abundant opportunity for observation of the various factors which influence egg production. The Vineland Contest, now in the second year of the second contest, is setting a new world's record for yearling hen production. Particular emphasis has been placed at the Vineland Contest on the study of external characteristics relating to measurements of egg-producing capacity. Another important line of research work conducted at this contest is the study of the influence of proportions of dry mash and scratch grain throughout the different seasons of the year. In the neighborhood of 7,000 chicks have been hatched from the pedigreed pens at Vineland and these furnish unlimited data on the inheritance of high fecundity.

The department administered the $3,000 available last year for the aiding and developing of poultry exhibitions. Six local county organizations benefited by this act, together with the Trenton Inter-State Fair and the State Poultry Show. By the encouragement thus given to poultry exhibitions, a new impetus to this sort of work was very noticeable.

The experiment conducted on the varying proportions of dry mash and scratch grain and varying proportions of meat scrap has been brought to a close. As yet data have not been assimilated or analyzed, but a glance at the figures would show that it is from the dry mash and a fairly high percentage of meat scrap in the ration that most eggs are produced.

The evening lunch furnished with artificial light in the poultry house for an hour during the evening, thus forcing the laying hens to work an extra hour and eat an extra meal, has been thoroughly tested and proven economical and profitable.

Continued study of the preparation of vaccine which might prevent or control chicken pox, roup and canker has been made with the result that during the coming year a vaccine similar to the California type will be distributed at cost throughout the state. It is hoped that sufficient follow-up work can be done in order to demonstrate the possible efficiency of this vaccine. Along this line it might also be said that over 700 post-mortem examinations have been made of birds dying in various sections of New Jersey. The outstanding point in this regard is the wide distribution of the round white worm as a parasite in New Jersey flocks.

A study of price variations in the New York market indicates that a new high-water mark for eggs was reached during October and November of last year, but that a new low-water mark for recent years was reached during the spring season of heavy production. With grain prices reduced and heavier supplies coming in, the market price of eggs also has fallen. The relation between these conditions, however, is still favorable to the poultry producer.

Conditions have been brought about during this past year which tend to bring the status of our research work back to something like normal conditions. This undoubtedly will mean that during the coming year poultry research activities can be fully resumed.

DAIRY HUSBANDRY

The activities of the department of dairy husbandry for the year ending June 30, 1921, may be listed as follows.

Experimental

Data have been gathered on six different experimental projects.

Extension

The department of dairy husbandry, cooperating with the department of extension, has given advice and assistance to the dairymen of the state through meetings, correspondence and personal visits. During the last half of the year two extension specialists in dairying have been employed on full time. On June 30, 1921, there were 6 active bull associations, 8 active cow-testing associations, 3 active state breeders' associations and 7 active local breeders' associations. Feeding demonstrations and extension dairy schools have been successfully carried on.

Advanced Registry

The amount of advanced registry work done was practically the same as last year. More tests were conducted last year than had been supervised by the department in any previous year. The year just closed showed a slight increase in the amount of semi-official testing done and a slight decrease in the number of short-time tests made.

Creamery Inspection

An excellent law, together with adequate funds, has made possible an organized inspection that has given protection to the farmers against unscrupulous purchasers of milk, and has served to create a better feeling between the buyer and seller of milk where the percentage of butterfat is used as the basis for payment. Six thousand five hundred and twenty-eight pieces of glassware were calibrated by this department. Two prosecutions were successfully carried out against creamerymen who had failed to observe the law.

Two hundred and sixty-one individual inspections were made of 109 milk plants. A total of 2,043 samples were check-tested.

AGRONOMY AND AGRICULTURAL ECONOMICS

The work of the department of agronomy and agricultural economics has been continued along the following lines.

Agronomy

The experimental work has included alfalfa variety and strain tests, studies of crop failures following alfalfa, relation of potato size of seed-piece to yield, potato variety tests and the establishing of superior strains of potatoes by hill selection and hill and tuber-unit comparisons.

The department also has begun the development of an admirably suited area of ground on the College Farm which is to be devoted to experimental work, including variety tests, breeding and improvement projects and trials of recent crop introductions appearing suitable to New Jersey conditions. It has also assembled more than fifty of the better strains of corn of the state which are being included in a corn-breeding project aiming at the fundamental improvement of this important crop.

Agricultural Economics

The agricultural economics work included the completion of a 3-year study of the cost of production of can-house tomatoes, studies on the cost of producing onions in 1920, the cost of milk production in 1921, and the cost of tractor operation, as well as the keeping of 40 complete cost accounts on as many selected farms. Records also have been obtained for the cost of operation of 37 farm trucks, which are to be included in further studies of farm power.

The loss of the chief of the department, who is absent on leave for work with the State Federation of County Boards of Agriculture, has necessarily limited, to some extent, the full activities of the department, although all major lines of endeavor have been carried on through the interim.

SEED CONTROL

The seed-control activities of the station are making themselves felt in the seed trade. There is more certain knowledge now than ever before among both dealers in and users of seed, concerning varieties, types, quality and purity of agricultural seeds sold in New Jersey Growers, seed-men, farmers and gardeners are availing themselves to an increasing extent of the facilities offered by the seed laboratories of the station. Among the samples tested during the year there should be mentioned 1,338 unofficial samples aside from the large numbers of official samples collected by the station's inspectors.

The department has rendered helpful service in identifying the numerous specimens of weeds and of weed seeds received from different localities. The reports on identifications are usually accompanied by advice as to methods of eradication. Still another of the activities of the seed laboratory relates to the collection and examination of cultures of bacteria offered as legume inoculants, that is, as furnishing active bacteria capable of producing nodules on the roots of legumes. Both official and unofficial samples of legume bacteria were examined and reported on. The examinations in question included laboratory studies as well as greenhouse tests in which commercial inoculants were compared as to their effectiveness for inoculating different legumes.

AGRICULTURAL EXTENSION

The work for the year has continued essentially along the lines of previous years. County agents have been continued in 18 counties of the state. Home demonstration agents have been employed in 8 counties and in the city of Paterson. County club agents have been employed in 8 counties. In club work 2 new counties were started. namely, Middlesex and Burlington. In both cases the counties cooperated in the employment of the agent. The policy of the extension service with reference to home demonstration and club work is to develop this work only as fast as the counties become interested and provide appropriation for cooperation in it.

All of the cooperative extension work as conducted in the counties is financed from public funds. We believe that this method of financing the work puts it on a much sounder basis than it would by private or cooperate contributions for its support.

Cooperating Agencies

The extension service cooperates officially with the United States Department of Agriculture and with the various counties of the state in the support of extension work. While the county funds are appropriated by the Board of Freeholders, and their expenditure is entirely under the supervision of the extension service, yet we recognize the county board of agriculture as being the organization which represents the county as a cooperating agency. The efficiency of extension work in any county is dependent upon a strong and active local cooperating organization. While work is done in cooperation with such organizations as the grange, farmers' clubs, public health service and State Department of Agriculture, yet we have recognized in each county the county board of agriculture, and our plans for work have been made in coöperation with that organization.

Finances for the Work

The funds used in cooperative extension work are derived from appropriations by Congress under the Federal Smith-Lever Act, direct appropriations by Congress to the United States Department of Agriculture to be allotted to the various states by the States Relations Service, the state appropriation for farm demonstration work and appropriations by the various counties in support of the demonstration work within the county. Extension work is performed through the services of county agents, home demonstration agents, boys' and girls' club agents and by subject-matter specialists who represent the Agricultural College and Experiment Station, and the United States Department of Agriculture. The subject-matter specialists work with the county agents, carrying to them expert assistance in the development of plans for work, and in carrying out these plans.

The Program of Work

Extension work as originally conducted dealt largely with the immediate problems as they came up from day to day, and from week to week throughout the year. With the progress of the work, however, it has been found that if permanent and lasting work is to be done, it must be based on the development of a program designed to meet the agricultural problems as they exist in the various counties. This program of work, in turn, must be based upon the development of a permanent, profitable and satisfactory agriculture in every county. In working out the program, the subject-matter specialists from the college meet with the county agents with special subject-matter committees, and together they consider the needs of the county, plans by which the work may be conducted, cooperators and demonstrators selected, and when the plans have finally been arranged, they are the results of the cooperative effort of the specialists from the college and interested subject-matter representatives from the counties and the county demonstration agents. This method of working out the program of work for every county has resulted in local interest and responsibility for the work not heretofore attained. Naturally, this plan has been carried out in some counties with greater success than in others, but we believe it is the right plan, and efforts will be made to bring about this method of procedure in every county.

Relationships Within the College and Experiment Station

The subject-matter specialists are considered as a part of the department with which they are associated, administratively responsible to the extension director, but responsible to the subject-matter department for the instruction which is given. In all cases the specialists have office space with the subject-matter departments, take part in the department conferences, and are considered as being representatives of the department in their extension work. Through the active support which has been given by the heads and assistants in the various departments, extension work has been greatly strengthened.

Needs in Extension Work

For the proper development of extension work in order that it may more adequately meet the needs of the state, we should have funds sufficient for the employment of a specialist in rural engineering, a specialist in animal husbandry and, in the home economics side of the work, a specialist in home management. These specialists cannot be employed until we receive increase in funds or reduce our contribution toward the salaries of the county agents. In order to care for the natural growth of the work in the counties we may expect within the next year to call for cooperation in farm demonstration work in at least one more county, and cooperation in the support of home demonstration work in at least two counties, and in junior demonstration, or boys' and girls' club work, in two counties. To care for the work now under way, and provide funds for growth along these lines above mentioned, would require an increase in our appropriation of not less than $25,000.

The director of extension and his associates have enjoyed the cordial support of the members of the research and teaching staffs of the station and college. Support no less cordial has been had from various cooperating agencies, notably the county boards of agriculture. As a result of this cooperation the extension service has been strengthened and made to fit into the county needs.

SOIL CHEMISTRY AND BACTERIOLOGY

Field and Cylinder Experiments

Work was continued during the past year on these projects in accordance with plans outlined in previous reports. Nitrogen determinations have been made on about 700 cylinder and field crop samples, and also on a number of miscellaneous samples.

Hydrogen-ion concentration and lime-requirement determinations have been made on samples of soil representing the 60 cylinders of group L. Also the total phosphoric acid and total lime have been determined in these samples and the total potash, magnesium and manganese in a number of them.

During the period May to November, 1920, samples of soil were collected at intervals of two weeks, from six of the limed and six of the unlimed nitrogenous fertilizer series of field plots, and hydrogen-ion concentration and nitrate-nitrogen determinations made. Lime-requirement determinations also were made on certain of these samples collected at intervals of six weeks.

The nitrogen availability work which has been running for 10 years on soils varying in mechanical composition has been completed and samples of soil collected for analysis. This analytical work is already partially completed.

A paper dealing with the results obtained from the magnesian and non-magnesian limestone experiment which has been under way for more than 10 years, was presented at the 1920 meeting of the American Society of Agronomy, and another paper dealing with the question of nitrogen accumulation and utilization as worked out in the cylinders, for 8 types of soil, has been accepted by Dr. E. J. Russell for publication in the Journal of Agricultural Science. Also two or three papers giving the results of work in this department have appeared in Soil Science during the year.

Sulfur Oxidation Experiments

Extensive laboratory experiments have been carried on to determine the extent to which sulfur is oxidized by a new sulfur organism. Oxidation has been allowed to proceed in an inorganic medium in the presence of tricalcium phosphate, and the results have been measured by determining the soluble sulfates and phosphate thus formed.

A field experiment was conducted during the summer of 1920 to determine the influence of varying amounts of sulfur on soil reaction and crop growth. Samples of soil were collected from these plots at intervals of two weeks, from May to November, for hydrogen-ion concentration and nitrate-nitrogen determinations. The results of this work have been reported in Soil Science.

Field experiments have also been conducted to determine the relative value of inoculated and uninoculated sulfur when this is used in connection with raw rock phosphate and with greensand marl.

Potato Fertilizer Experiments

The fertilizer ratio experiment with potatoes which is being conducted at the station in cooperation with the Bureau of Plant Industry, and also the fertilizer experiment at Elmer, in Salem County, in cooperation with J. Harry Kandle, were both continued during the season of 1920. This gives two years' results for the former and four for the latter. The yield in the Elmer experiment last year was the largest since the work was started. A summary of this work for the first three years was published in New Jersey Agriculture for August, 1920, and a summary of the four years' results was given out on mimeographed sheets at the winter meeting of the Potato Growers' Association. The work at both places is being continued this year.

Other Experiments

Several new projects have been undertaken this year, some of which are being carried on by graduate students. Among these may be mentioned the comparison of different forms of lime by R. M. Barnette, the influence of fertilizers on germination by Dana G. Coe, and the influence of sulfur on the solubility of the potash in greensand marl by Willem Rudolfs.

Considerable work also has been done toward the analysis of soil samples sent in by the State Soil Survey party.

A number of miscellaneous samples have been identified and lime-requirement determinations made on soils sent in by residents of the state.

Borax Fertilizer Experiment with Corn and Potatoes

This project was started in 1920 in cooperation with the Bureau of Plant Industry, United States Department of Agriculture. The object of this experiment was to determine to what extent borax in the fertilizer will prove injurious to potatoes and corn.

For potatoes a standard 4-8-4 fertilizer was used, and to this there was added anhydrous borax in amounts varying from 1 pound to 400 pounds per acre. Plots receiving this mixture were compared with check plots, that is, plots which received the fertilizer without any borax.

When the borax was applied two weeks before planting the injury was much less than when applied at the time of planting.

With amounts of borax up to 30 pounds per acre the injury was slight. Applications of 50 pounds or over per acre had a distinct depressing effect with respect to both germination and growth.

The effect of the borax on the corn was quite similar to its effect on the potatoes. It is probably slightly more toxic to the former than to the latter.

The cover crop of rye which followed the potatoes did not appear to be injured even where the application of borax amounted to 200 and 400 pounds per acre.

Potatoes have been planted again this year on the same plots in order that the residual effect of the borax may be noted.

Buildings and Equipment

The addition to the soil house which was started about a year ago was completed last August and has proved a valuable contribution. the lower part being used for storing and mixing fertilizers and the upper part for storing crop samples.

A small power threshing machine was purchased for use in threshing samples of grain and soybeans.

A careful examination of the cylinders early in the spring showed that a good many of these were rusting through just at the surface of the ground. Most of those that were in bad shape have now been repaired by the use of strips of galvanized iron and roofing cement. Beneath the ground the cylinders appear still to be in good shape.

No important additions have been made to the laboratory equipment during the year. For the coming year, we shall need additional book shelves, and considerable glassware and other apparatus, including an oil immersion objective.

PLANT PHYSIOLOGY

The work of the department of plant physiology has continued during the year along lines of research similar to those carried out during the preceding year. The work has been vigorously prosecuted and it is gratifying to be able to report that fine progress has been made with the problems under investigation. The year's accomplishment exceeds that of any previous year.

Most attention has been given to the study of the salt nutrition of plants and to closely related problems. A special study was made of the salt requirements of the soybean plant during the early or vegetative stage of development. The results of this work are given in the departmental report. The work which was carried out last year on the salt requirements of the potato has been repeated, and in the main last year's results have been confirmed.

A preliminary study has been made of the effect upon plant growth of constantly aerating the medium in which the plants were grown, and at the same time continually renewing the mineral nutrients by "drip and drain" methods. The work was carried out with solution and sand cultures and some surprising results were obtained. By constant aeration and continual renewal of the salt nutrients the yields were more than double those obtained from similar cultures not aerated and in which the salt nutrients were renewed only every three or four days. The superior yields were due not so much to the constant renewal of the salt nutrients as to the perfect aeration of the media.

The experimental work carried out with the muck soils of Bergen County has clearly demonstrated that these soils can be greatly improved for the growth of celery by a moderate application of fertilizer mixtures which are relatively low in nitrogen and potassium and high in phosphorus.

The study of the relation of hydrogen-ion concentration to plant growth has been continued. Special attention has been given to the rates of change in the hydrogen-ion concentration of nutrient media produced by the growing plants, and it has been determined that this change in reaction has considerable influence upon the availability and efficiency of certain elements. Experiments dealing with some of the factors affecting the rates of change in reaction also have been carried out. An attempt is now being made to determine what are the underlying causes of the change in reaction which a nutrient medium undergoes during contact with the roots of growing plants. During the past year this line of research has been carried out in connection with the study of ammonium sulfate in relation to plant growth and considerable progress has been made. The experimental work on iron availability has been continued and some results of practical importance have been obtained also in connection with the study of ammonium sulfate. The work thus far has been confined largely to the use of the inorganic iron compounds in solution and sand cultures, and that considerable progress has been made is indicated in the departmental report. Similar studies with organic iron compounds have not yet been undertaken.

A new project was organized during the year involving an important line of research, namely, a study of the rates of plant growth and of actual crop production of various species of agricultural plants in relation to the size, weight and quality of the seed. Although this work has been in progress only for a comparatively short period of time, some important results have already been obtained.

Considerable time has been given also to the study of many minor problems which are continually arising in connection with the experimental work carried out under the various projects. It is, of course, essential that these minor problems receive careful attention in order that successful progress may attend the main lines of research.

ENTOMOLOGY

During the year just closed this department has had under consideration ten different projects known as: (1) mosquito control; (2) climate and insect investigations; (3) orchard insect investigations; (4) stickers, spreaders and dilutents for spraying and dusting mixtures; (5) small fruit investigations; (6) vegetable insect investigations; (7) arthropods injurious to poultry production; (8) insects injurious to market milk; (9) cranberry problems; (10) biology of sewage disposal.

Two projects, one a revival and the other new, were filed about June 20, 1921, entitled: green-house insect investigations and soil infesting insect investigations.

Mosquito Control

Work has been continued along the same lines as last year—discovery and elimination of mosquito breeding on 120,000 acres of salt marsh and 320,000 acres of upland, maintenance of drainage systems both on upland and salt marsh in good working condition, and the accomplishment of as large an amount of drainage, filling, cleaning and stocking with fish as the funds would permit.

With the exception of the ditching in the Cumberland County salt marsh, which is roughly 600,000 feet, the entire drainage system on the salt marsh amounting to fully 17-½ millions of feet of ditching 10 inches wide, or its equivalent, have been gone over and the obstructions removed; 1,861,020 feet has actually been recut and 1,604,946 feet of new ditching has been installed; 383,797 linear feet of upland ditching has been recut and as large but indeterminated footage installed. The patrol and temporary elimination, covering 120,000 acres of salt marsh and 320,000 acres of upland, has been carried out.

The result of this work has offered a very considerable degree of protection to about 2-½ millions of people, and immense sums have been invested in industrial plants, summer homes and all-year-around dwellings in areas that were once too badly mosquito-ridden to be attractive for such improvement.

Climate and Insect Investigations

Three sets of experiments with the bean weevil on the relation of atmospheric moisture to the rate of insect metabolism have been completed. The results have been averaged and curves to represent the results have been constructed. These curves are very nearly straight lines and show a variation of two-tenths of a day for each per cent of change between 7.1 and 80 per cent.

A study has been made of the effects of low atmospheric moisture for the protection of seeds against certain seed-infesting insects. Preliminary to this study determination was made of the effect of loss of water on the viability of corn, beans and peas. It was found that the removal of water beyond a certain point, which was variable for each species, reduced germination. The hygroscopic power of certain common cheap substances, such as CaO (lime), $CaCl_2$ (calcium chloride), CaOH (hydrated lime) and Milltown Ball Clay No. 9, was determined, and it was found that while CaO and $CaCl_2$ had considerable hygroscopic power, CaOH and the clay had almost none. Quantities of beans were enclosed in glass in two ways—with a thick layer of cotton between the beans and the ground substance, and with the beans and the substance mixed in various proportions. Beetles were placed in each of the jars and covered with cheese-cloth. Some of the beetles succeeded in coming through in all jars with the cotton layer between. Some beetles came through in the dust mixture of CaOH, in the smaller amounts of CaO. Beans were crushed and broken in the CaO and were wet and ruined in the $CaCl_2$. When the beans were mixed with Milltown Ball Clay No. 9, at the rate of 16 to 1, they were completely protected from injury. It must be concluded, therefore, that the common cheap substances experimented with act as contacts, and that the Milltown Ball Clay No. 9 gives the best protection without fear of injury to the seed.

A study was made of the degree of heat which would destroy various seed-infesting insects. It was first necessary to determine the time necessary to heat the seed to the temperature of the chamber, the curves representing the time at different temperatures. In beans, corn and ground barley the time required at 110° F. increased steadily until 130 to 140° F., when the time very rapidly decreased at 150° F. to less than the starting point, with all except corn. One hour of heating beyond the time necessary to bring the mass to the temperature of the chamber seems to kill the adult, pupa and larva of the bean weevil (*Echocerus cornutus*) and the larva of the dermestid (*Trogoderma tarsale*) at a temperature of 150° F. without damage to the viability of the seed concerned. Considering the relatively short time necessary to bring the mass to the necessary temperature it seems that 150° F. is probably the best temperature to use.

Orchard Insect Investigations

The delayed dormant spray to which 40 per cent nicotine has been added at the rate of 1 to 500 appears to be a specific for the oat aphis, rosy apple louse and green apple aphis. The last species has for the last two years reappeared in the water sprouts in midsummer, seeming to come in from outside the treated orchard on the wing. The reappearance of this species is being watched for this season and an attempt will be made to destroy it with 40 per cent nicotine and soap.

The pear psylla appears to yield to the treatment outlined in the spraying schedule when this is carefully and conscientiously carried out.

Again, during the last season the codling moth exhibited two broods at Glassboro and the numerous side-worms appear to belong to that species. This insect was controlled at Maple Shade by the sprays outlined in the schedule, but at Glassboro the schedule treatments failed to effect a control. A set of blocks, to one of which sufficient accessory sprays are being applied to insure maintenance of coating during the period of entry of both broods, is being carefully treated at Glassboro during the present season.

Our knowledge of the use of paradichlorobenzene for peach-borer control has been considerably extended during the present year. It has been found that fall treatments on trees 6 years of age or older kill 95 per cent of the larvæ and cause little or no injury to the trees. Treatments of young trees with short-time fall application (10 to 14 days' exposure) kill 80 per cent or more of the larvæ and produce little or no injury. Further experimental work is needed to determine the effectiveness and safety of the treatments on young trees.

The tests on the relative value of spray and dust methods of applying insecticides for control of plum curculio, codling moth, apple aphis and apple leaf hoppers showed that the dust mixtures were only about one-half as efficient in the control of the first two species and considerably less efficient in the control of the last two. They also indicated that the lack of efficiency in the dust for the first two species was due to its having been quickly washed from the trees by rain. No definite results can be recorded at this time in connection with the investigations on stickers, spreaders and dilutents; small fruit insects; vegetable insects; arthropods injurious to poultry; and insects injurious to market milk.

Investigation of Cranberry Problems

The tests made during this year confirmed the results of 1919 in showing that 20 pounds of nitrogen drawn from nitrate of soda is nearly the optimum for annual treatments on Savannah land. This study will be carried through another year before the results are considered final. Additional data have been secured concerning the optimum amount of phosphoric acid for annual treatments on cranberry land, but no definite recommendation can be made at this time. The applications of a mixture of mineral and organic nitrogen on Savannah land did not yield as large a crop as an application of an equivalent amount of nitrogen drawn from nitrate of soda alone, but the mixture produced larger yields than an equivalent amount of nitrogen drawn from dried blood alone. This study is to be carried through another year before it is discontinued. The optimum amount of the mixed fertilizer appears to be from 500 to 800 pounds to the acre annually.

Barium phosphate and calcium cyanamide gave no increases that could encourage their use and the test has been discontinued.

On mud bottom, nitrogen cannot be used in as large quantities as on Savannah soil. On the other hand, phosphoric acid in large amounts appears to be quite as essential and potash gave no definite results within the first year.

The optimum hydrogen-ion concentration on Savannah cranberry land appears to be 4.4 to 4.6. This has been obtained by adding ground limestone at the rate of 4,000 pounds per acre.

The cranberry girdler cannot be controlled by applications of sodium cyanide at the rate of 200 pounds to the acre. This substance does not reach the insect in lethal doses even when diluted in 40,000 gallons of water.

The cranberry blossom worm has proven a serious pest during the year and an immediate control seemed to be important. Complete submergence for 24 hours, between May 25 and June 5, appeared to destroy nearly 100 per cent of the worms.

Our knowledge of cranberry weeds has been extended by a systematic study of the flora of New Jersey bogs. Control measures will be attempted now that the flora are listed.

Some data have been collected on the effect of flooding on the cranberry plant during the fall. They are not sufficiently complete to warrant their discussion at this time.

Investigations of the Biology of Sewage Disposal

The work during the present year has been devoted to determining the identity of certain plants and animals found in the sprinkling sewage filter. There were found, identified, and described: *Oscillatoria limosa, Arthrospira junneri, Mougeotia sphærocoipa, Ulothrix subtilis, Binulearia* sp., *Cladophora crispata, Monhystera* sp., *Rhabditis* sp., *Plectus* sp., *Nais* sp., *Dero* sp., *Naidum* sp., *Pristina* sp., *Timnodrilus* sp., *Tubifix* sp., and *Leucophenga* sp.

The first six are species of algæ, and the rest are Nematodos (the next three), Oligochæta (the next eight genera), and the last a dipterous insect.

Careful drawings were made of all these species.

Greenhouse Insect Investigations

(1) Apparatus for determining the concentration of hydrocyanic acid gas (HCN) in the atmosphere was devised.

(2) By means of this apparatus the following facts regarding distribution of the gas were obtained:

(a) Maximum density of HCN is reached in from 4 to 6 minutes.

(b) Concentration usually first appears in the comb.

(c) The size of the greenhouse and the amount of the charge appear to have little or no effect upon the distribution of the HCN.

(d) The size of the house appears to have little or no effect upon the loss of HCN, but the tightness of the house appears to be the important factor.

(e) Air currents within the house appear to affect greatly the degree of density of HCN.

(f) Unevenness of density can best be overcome by multiplying the points of discharging the HCN.

(g) Temperature and atmospheric moisture have little effect within greenhouse limits, but greater densities appear to be correlated with lower temperatures and higher moistures.

(3) The minimum dosage for plant lice (principally rosy aphis) appears to be affected by temperature, but the amount of dosage appears to be much more important; 0.0001 gm. of HCN per liter fails to kill even in 30 minutes at a temperature of 100° F., 0.00015 gm. per liter kills at 80° F. in 30 minutes, but in 15 minutes only 50 per cent are destroyed; the same dosage at 100° F. kills in 15 minutes;

0.002 gm. of HCN per liter kills everything in temperatures ranging from 40° F. to 100° F.

The minimum dosage for these insects in a tight receptacle under greenhouse temperatures of 40° to 100° F. is about 0.0002 gm. of HCN per liter.

In practical greenhouse fumigation for the rosy aphis the charge of 5/8 ounce to 1,000 cubic feet should theoretically give a density of 0.000312 gm. per liter, but as a matter of fact the density over the benches does not usually exceed 0.0003 gm. of HCN per liter. Even this is much larger than the minimum dosage in a closed receptacle, exceeding it by 0.0001 gm. per liter.

PLANT PATHOLOGY

The organization of the department was practically the same as last year. The force consisted of Dr. Wm. H. Martin, working on the diseases of potatoes; R. F. Poole, working on the diseases of celery, horseradish, sweet potatoes and tomatoes; C. M. Haenseler, working on fungi injurious to paints and on the wilt of eggplant and leaf and fruit spot of the pear; W. D. Moore, working on root rots of peas and corn; and G. W. Fant, working on brown rot of peach and seed-bed diseases.

The epidemics in 1920 were the brown rot of peach, late blight of potato, common scab of potato, leaf spot of cherry, wilt of eggplant, black leg of cabbage, streak of tomato, and in 1921 the bacterial rot of seed potatoes. There were many other important diseases, some of which may become very serious under favorable conditions.

There is need for the services of an associate plant pathologist who could undertake the development of disease-resistant strains. The root rot of the pea, wilt of the tomato, wilt of eggplant and black leg of cabbage are outstanding cases of plant diseases that can be best controlled by the development of resistant varieties. However, there are many other diseases that should receive attention. Other important lines of work which are neglected at the present time are diseases of grain and forage crops, small fruits and vegetables, and the storage of fruits and vegetables in such manner as to protect them from diseases.

OYSTER INVESTIGATIONS

The biologist of the station became, on July 1, 1920, also the biologist of the New Jersey State Board of Fisheries. In this dual capacity he was able to make definite progress in the study of a number of the important factors that affect our oyster industry. His technical knowledge of the chosen subject was utilized by other state and national agencies. Thus he was called upon to co-operate with the State Department of Health in making a survey of the upper

Delaware Bay for the purpose of determining the extent of pollution and its effect on the propagation of oysters. He was asked to appear at Providence, R. I., as expert witness in the case of Rooks vs. Mexican Petroleum Company as to the effect of oil upon oysters. The American Biological Society appointed him chairman of its committee on pollution of land and coastal waters. At the invitation of the Secretary of Commerce he attended a conference called at Washington to consider the subject of pollution and conservation as applied to the fisheries. The Secretary appointed him a member of the permanent committee on pollution. Papers were presented by the biologist at the National Convention of the American Public Health Association, San Francisco, Cal., September, 1920; and the American Association for the Advancement of Science, Chicago, Ill., December, 1920.

PUBLICATIONS

The department of publications during the past year has continued the lines of work previously adopted, with some new developments. The work on publicity and publications has been organized on a project basis and a definite program followed. Publicity programs for each department in the institution were adopted at the beginning of the fiscal year and have been used as a basis for the activities of the department of publications. Such a plan has contributed much toward the efficiency of the work and will be continued throughout the ensuing year.

The monthly publication, New Jersey Agriculture, has proven so successful that beginning with July 1, 1920, it was distributed to the entire mailing list. At the close of the year an edition of 12,000 copies was being printed. Also, in order to provide more space for the research activities of the Experiment Station, the size of the issue was increased from 8 to 16 pages on alternate months.

The number of scientific papers contributed by members of the Experiment Station staff to technical journals has been increasing and beginning in May, 1920, a journal series was established. Technical papers prepared by members of the staff are submitted to the director and before being forwarded to the publishers of the scientific journals are given a series number. Reprints of the papers are purchased by the Experiment Station and placed on file for future distribution. At this writing, over 30 papers have already been entered in the journal series. A list of these papers appears below.

Exhibits of Experiment Station publications were made at the meeting of the State Horticultural Society at Atlantic City, in December, during Agricultural Week at Trenton in January, and during the Summer Field Meeting at the Experiment Station in June. Also, an exhibit of the year's publications and publicity material was made at the annual conference of the American Association of Agricultural College Editors at the University of Missouri in May. In competition with exhibits of the agricultural colleges and experiment stations of other states, New Jersey was awarded second place.

Relations with the newspapers of the state have continued cordial, with evidence of increasing use of the agricultural news issued through the station and college news service. The personal survey by the editor of newspapers of the state, dailies of New York and Philadelphia and farm papers in the East, has been continued as far as time would permit.

The department is co-operating with the State Federation of County Boards of Agriculture in publicity work. A memorandum of agreement has been adopted jointly by the Publicity Committee of the State Federation and a special committee on publicity representing the extension division of the college and station. This agreement avoids overlapping in the publicity work of the two bodies and assures effective co-ordination.

Among the needs of the department may be mentioned the revision of the mailing list. It is planned to make a complete revision of the list during the next fiscal year. The department is also badly in need of additional room, especially for shelving space, filing furniture and storage of publications.

A list of the publications of the year follows:

Publications

Bulletins

No.

343 Analyses of Materials Sold as Insecticides and Fungicides During 1920. Charles S. Cathcart and Ralph L. Willis.

344 Analyses of Commercial Fertilizers, Fertilizer Supplies and Home Mixtures, 1920. Charles S. Cathcart.

345 Studies on Tomato Leaf-Spot. William H. Martin.

346 The Chemical Composition of the Soils of the Camden Area of New Jersey. A. W. Blair and H. C. McLean.

347 The Artificial Incubation and Brooding of Turkeys. H. W. Graybill.

348 The Mosquitoes of New Jersey and their Control. Thomas J. Headlee.

349 Analyses of Commercial Fertilizers and Ground Bone; Analyses of Agricultural Lime. Charles S. Cathcart.

350 Fertilizer Registrations for 1921. Charles S. Cathcart.

351 Aids to Successful Oyster Culture. I. Procuring the Seed. Thurlow C. Nelson.

352 A Study of the Biology of the Sprinkling Sewage Filter. J. Wallace Thomson.

353 Costs, Profits and Practices of the Can-House Tomato Industry in New Jersey. Frank App and Allen G. Waller.

354 Analyses of Commercial Feeding-Stuffs and Registrations for 1921. Charles S. Cathcart.

203 Some Household Pests. (Reprint.)

Circulars

121 Buying and Selling Milk on a Butterfat Basis. Forrest C. Button.

122 Potato Diseases in New Jersey. Mel. T. Cook and William H. Martin.

123 Diseases of Sweet Potatoes. Mel. T. Cook and Robert F. Poole.

124 A Complete Fertilizer for Savannah Cranberry Land. Charles S. Beckwith.

24 The Home Preparation of Lime and Sulfur Mixtures. (Reprint.)
97 Common Diseases of Ornamental Plants. (Reprint.)
98 Common Diseases of Shade and Ornamental Trees. (Reprint.)
101 The Home Butchering and Curing of Pork. (Reprint.)
116 Spray Calendar for Apples and Quinces. (Reprint.)
117 Spray Calendar for Peaches. (Reprint.)
118 Spray Calendar for Pears. (Reprint.)
119 Spray Calendar for Plums. (Reprint.)
120 Spray Calendar for Cherries. (Reprint.)

Reports

1920 Forty-first Annual Report of the New Jersey State Agricultural Experiment Station, and Thirty-third Annual Report of the New Jersey Agricultural College Experiment Station.

New Jersey Agriculture

Vol. 2, Nos. 7-12.
Vol. 3, Nos. 1-6.

Hints to Poultrymen

Vol. 8, No. 10, July, 1920.
Broodiness: Its Influence and Control. **Ralston R. Hannas.**
Vol. 8, No. 11, August, 1920.
A Campaign Against Dangerous Poultry Parasites. **Willard C. Thompson.**
Vol. 8, No. 12, September, 1920.
The Improved New Jersey Multiple Unit Laying House. **Irving L. Owen** and **George H. Pound.**
Vol. 9, No. 1, October, 1920.
The Economics of Artificial Illumination. **Harry R. Lewis.**
Vol. 9, No. 2, November, 1920.
Ways and Means of Feeding the Laying Hens. **Willard C. Thompson.**
Vol. 9, No. 3, December, 1920.
The Handling and Packing of Market Eggs. **George H. Pound.**
Vol. 9, No. 4, January, 1921.
A Method of Keeping Poultry Records and Accounts. **Irving L. Owen.**
Vol. 9, No. 5, February, 1921.
How to Hatch More and Better Chicks. **Elmer H. Wene.**
Vol. 9, No. 6, March, 1921.
Coal Stove Colony Brooding. **Irving L. Owen.**
Vol. 9, No. 7, April, 1921.
A Campaign to Control Chicken Pox. **Willard C. Thompson** and **Linden S. Dodson.**
Vol. 9, No. 8, May, 1921.
Milk a Panacea for Poultry Ills. **Harry R. Lewis.**
Vol. 9, No. 9, June, 1921.
Culling: A Practical Plan to Eliminate the Non-Producing Hen. **W. H. Allen.**

(Reprints) Vol. 6, No. 8.
Vol. 7, No. 7.
Vol. 8, Nos. 1, 2, 5, 6, 8, 11.
Vol. 9, Nos. 1, 2.

Extension News Service

Timely Tips to Gardeners—Nos. 13-20 (1920) 1-11 (1921).
Rural Ruminations—Nos. 22-45.
Home Cogitations—Nos. 7-25.
Miscellaneous stories from the different departments published weekly for the use of the weekly, the daily and the agricultural press.

List of Available Publications, December, 1920.

Journal Series

(Published or in Press)

No. 1. J. G. Lipman and A. W. Blair. Field Experiments on the Availability of Nitrogenous Fertilizers, 1908-1917. *Soil Science,* May, 1920.

No. 2. J. R. Neller. The Potential Biochemical Activity of the Spores of Soil Bacteria. *Soil Science,* May, 1920.

No. 3. W. H. Martin. The Relation of Sulfur to Soil Acidity and to the Control of Potato Scab. *Soil Science,* May, 1920.

No. 4. J. R. Neller. The Oxidizing Power of Soil from Limed and Unlimed Plots and its Relation to Other Factors. *Soil Science,* July, 1920.

No. 5. William H. Wood Komp. The Use of Carbon Bisulfide Against the White Grub. *Soil Science,* July, 1920.

No. 6. Jacob S. Joffe. The Influence of Soil Reaction on the Growth of Alfalfa. *Soil Science,* October, 1920.

No. 7. Charles S. Beckwith. The Effect of Fertilizers on Blueberries. *Soil Science,* October, 1920.

No. 8. J. G. Lipman and J. S. Joffe. The Influence of Initial Reaction on the Oxidation of Sulfur and the Formation of Available Phosphates. *Soil Science,* October, 1920.

No. 9. Alvah Peterson. Some Studies on the Effect of Arsenical and Other Insecticides on the Larvæ of the Oriental Peach Moth. *Journal of Economic Entomology,* October, 1920.

No. 10. Ernest Van Alstine. The Determination of Hydrogen-Ion Concentration by the Colorimetric Method and an Apparatus for Rapid and Accurate Work. *Soil Science,* December, 1920.

No. 11. Linus H. Jones and John W. Shive. The Influence of Iron in the Forms of Ferric Phosphate and Ferrous Sulfate upon the Growth of Wheat in a Nutrient Solution. *Soil Science,* January, 1921.

No. 12. William H. Martin. A Comparison of Inoculated and Uninoculated Sulfur for the Control of Potato Scab. *Soil Science,* January, 1921.

No. 13. J. G. Lipman, A. W. Blair, W. H. Martin and C. S. Beckwith. Inoculated Sulfur as a Plant-Food Solvent. *Soil Science,* February, 1921.

No. 14. Gertrude E. MacPherson. The Comparative Morphology of the Dodder and the Morning-Glory. *Botanical Gazette,* May, 1921.

No. 15. W. Rudolfs. Effect of Salt Solutions Having Definite Osmotic Concentrations Values Upon Absorption by Seeds. *Soil Science,* April, 1921.

No. 16. T. J. Headlee. Dusting vs. Spraying for Insect Control. *Proceedings of the New Jersey State Horticultural Society,* 1920.

No. 17. T. J. Headlee. The Response of the Bean Weevil to Different Percentages of Atmospheric Moisture. *Journal of Economic Entomology.*

No. 18. T. J. Headlee. Dusting as a Means of Controlling Injurious Insects. *Journal of Economic Entomology.*

No. 19. Alvah Peterson. Some Soil Fumigation Experiments with Paradichlorobenzene for the Control of the Peach-Tree Borer, *Sanninoidea Exitiosa* Say. *Soil Science,* April, 1921.

No. 20. A. W. Blair and B. E. Brown. The Influence of Fertilizers Containing Borax on the Yield of Potatoes and Corn. *Soil Science,* May, 1921.

No. 21. C. M. Haenseler. The Effect of Salt Proportions and Concentration on the Growth of *Aspergillus Niger.* *American Journal of Botany,* March, 1921.

No. 22. T. J. Headlee. Methods and Results of Mosquito Extermination in New Jersey. *Proceedings of the Society for the Promotion of Agricultural Science,* 1920.

No. 23. J. G. Lipman and A. W. Blair. Nitrogen Losses Under Intensive Cropping. *Soil Science*, July, 1921.

No. 24. J. G. Lipman, A. L. Prince and A. W. Blair. The Influence of Varying Amounts of Sulfur in the Soil, on Crop Yields, Hydrogen-Ion Concentration, Lime-Requirement and Nitrate Formation. *Soil Science*, September, 1921.

No. 25. Charles S. Beckwith. The Effect of Fertilizer Treatments on Savannah Cranberry Land. *Soil Science*, August, 1921.

No. 26. Mel. T. Cook. The Blossom Blight of the Peach. *Phytopathology*.

No. 27. Mel. T. Cook. Falling Foliage. *Phytopathology*.

No. 28. Linus H. Jones and J. W. Shive. The Effect of Ammonium Sulfate upon Plants in Nutrient Solutions Supplied with Ferric Phosphate and Ferrous Sulfate as Sources of Iron. *Journal of Agricultural Research*.

No. 29. Mel. T. Cook. Morphological Studies on Peach Yellows and Little Peach. *Botanical Gazette*.

No. 30. J. R. Neller and W. J. Morse. Effects upon the Growth of Potatoes, Corn and Beans Resulting from the Addition of Borax to the Fertilizer Used. *Soil Science*, August, 1921.

No. 31. Jacob S. Joffe. Studies of Sulfur Oxidation in Sulfur-Floats-Soil Mixtures. *Soil Science*.

No. 32. Selman A. Waksman. Microorganisms Concerned in the Oxidation of Sulfur in the Soil. I. Introductory. *Journal of Bacteriology*.

No. 33. Selman A. Waksman and J. S. Joffe. Microorganisms Concerned in the Oxidation of Sulfur in the Soil. II. Thiobacillus Thiooxidans, A New Sulfur-Oxidizing Organism. *Journal of Bacteriology*.

No. 34. Selman A. Waksman and Jacob S. Joffe. The Oxidation of Sulfur by Microorganisms. *Proceedings Society for Experimental Biology and Medicine*, Vol. 28, p. 1-3.

No. 35. Selman A. Waksman and Jacob S. Joffee. Acid Production by a New Sulfur-Oxidizing Bacterium. *Science*, March, 1921.

No. 36. Jacob G. Lipman. Some of the New Applications of Sulfur in Agriculture. *Chemical Age*, July, 1920.

No. 37. Jacob G. Lipman. The Value of Liming in a Crop Rotation with and without Legumes. *Journal American Society Agronomy*.

No. 38. Thurlow C. Nelson. Some Aspects of Pollution as Affecting Oyster Propagation. *American Journal Public Health*, June, 1921.

No. 39. W. Rudolfs. Experiments with Common Rock Salt: I. Effect on Asparagus. *Soil Science*.

No. 40. W. Rudolfs. Experiment with Common Rock Salt: II. Eradication of Weeds and Cleaning of Roadsides with Salt. *Soil Science*.

No. 41. W. Rudolfs. Experiments with Common Rock Salt: II. After Effects of Salt. *Soil Science*.

No. 42. J. G. Lipman, S. A. Waksman and J. S. Joffe. The Oxidation of Sulfur by Soil Organisms. *Soil Science*.

No. 43. Ernest Van Alstine. Sodium Nitrate Fertilizer as a Physiologically Alkaline Salt and the Development of Chlorosis of Plants under Alkaline Conditions. *Soil Science*.

No. 44. J. R. Neller. The Influence of Growing Plants upon Oxidation Processes in the Soil. *Soil Science*.

No. 45. Jacob S. Joffe. Preliminary Studies on the Isolation of Sulfur Oxidizing Bacteria from Sulfur-Floats-Soil Composts. *Soil Science*.

No. 46. W. M. Regan and S. W. Mead. Factors Affecting the Composition of Milk for a Period of Two Days. *Journal Dairy Science*.

No. 47. Alvah Peterson. Some Studies on the Influence of Environmental Factors on the Hatching of the Eggs of *Aphis Avenæ* Fab., and *Aphia Pomi DeG*. *Annals of the Entomological Society of America*, Vol. 13, p. 391-400.

No. 48. Thomas J. Headlee. Some Experience with the Codling Moth. *Journal Economic Entomology*, Vol. 13, p. 166-172.

No. 49. Thomas J. Headlee. The Present Status of the Gypsy Moth in New Jersey. *Journal Economic Entomology*, Vol. 14, p. 172-177.

Technical Papers

APP, FRANK

Review of Illinois Bul. 231, "The Horse and the Tractor"—*Journal of Farm Economics*, April, 1921.

Review of Farmers' Bul. 1093, "Influence of the Tractor and Use of Horses"—*Journal of Farm Economics*, to be published.

Review of Cornell Memoir 34, "Economic Study of Farm Layout"—*Journal of Farm Economics*, April, 1921.

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New Jersey to Undertake the Control of Chicken Pox by Vaccination—*Journal of the American Association of Instructors and Investigators in Poultry Husbandry*, July, 1920.

HANNAS, RALSTON R.

Embryo Mortality—*Journal of the American Association of Instructors and Investigators in Poultry Husbandry*, July, 1920.

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Report of the State Entomologist, Bul. 27, Department of Agriculture. (Gipsy Moth and Japanese Beetle)—*Official Proceedings 6th Annual Agricultural Convention*, 1921.

Gipsy Moth Problem as it Exists in the Metropolitan District (New York City and Vicinity)—*Proceedings New York Farmers' Meeting* of January 18, 1921.

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Summary of the State and County Work—*Proceedings 7th Annual Meeting New Jersey Mosquito Extermination Association*, 1920.

Control of the Principal Insects Injurious to Apple and Pear Trees above Ground—*Proceedings Connecticut Pomological Society*, 1920.

LIPMAN, JACOB G.

The American Association for the Advancement of Science, Section O-Agriculture—*Science*, Vol. LII, No. 133, July 16, 1920.

NELSON, THURLOW C.

The Conservation of New Jersey's Oyster Industry.

Report of the New Jersey Board of Shellfisheries for 1920, p. 8-15. Trenton.

THOMPSON, W. C.

A Practical Test of the Blood Agglutination Technic "Rettger" in a Bacillary White Diarrhea Case in New Jersey—*The Journal of the American Association of Instructors and Investigators in Poultry Husbandry*, Nov., 1920.

The Control of Internal Parasites Essential to Poultry Health—*The Journal of the American Association of Instructors and Investigators in Poultry Husbandry*, July, 1920.

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The Curriculum of the College of Agriculture—*U. S. Bur. Ed. Bul.* 1920, No. 40.

Popular Papers

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Hessian Fly Injury to the New Jersey Wheat Crop—*New Jersey Agriculture*, July, 1919.

Hessian Fly Injury to the New Jersey Wheat Crop—*American Agriculturist*, August 26, 1920.

Aid for Distribution and Marketing of Farm Products and Adjusting the Farm Business—*New Jersey Agriculture*, April, 1921.

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List of Projects of the New Jersey Agricultural Experiment Stations, 1920-21

DEPARTMENT OF AGRONOMY

Station Number	Department Number	Subject	Leader	Associate
A. 1	F. M. 2	Cost of Producing General Farm Crops in New Jersey.	Frank App	A. G. Waller
A. 2	F. M. 3	Cost of Potato Production.	Frank App	A. G. Waller
A. 3	F. M. 4	Cost of Farm Power.	Frank App	A. G. Waller
A. 4	F. M. 5	Methods of Maintaining Soil Fertility.	Frank App	
A. 5	Agronomy 100	Corn on Alfalfa Sod.	Frank App	
A. 6	Agronomy 101	Potatoes on Alfalfa Sod.	Frank App	
A. 7	Agronomy 102	Alfalfa Strains.	Frank App	A. G. Waller G. W. Musgrave
A. 8	Agronomy 202	Size of Potato Seed Piece.	Frank App	G. W. Musgrave
A. 9	F. M. 1	Cost of Tomato Production.	Frank App	A. G. Waller

DEPARTMENT OF DAIRY HUSBANDRY

Station Number	Department Number	Subject	Leader	Associate
D. H. 1	1	Breeding for High Production in Dairy Cattle.	W. M. Regan	S. W. Mead
D. H. 2	2	Feeding Milk Cows During the Dry Period.	W. M. Regan	S. W. Mead
D. H. 3	3	Corn and Alfalfa Versus More General Ration for Dairy Feeding.	W. M. Regar	S. W. Mead
D. H. 4	6	Minimum Milk Requirement for Raising Dairy Calves.	W. M. Regan	S. W. Mead
D. H. 5	7	Factors Affecting the Total Butterfat Content of Cow's Milk During a Period of Two Days.	W. M. Regan	S. W. Mead
D. H. 6	4	Cut Alfalfa Hay as a Supplemental Feed for Purchased Grains in Feeding Dairy Cows.	W. M. Regan	S. W. Mead
D. H. 7	5	Rations for Dairy Heifers During the Winter Months.	W. M. Regan	S. W. Mead

DEPARTMENT OF ENTOMOLOGY

Station Number	Department Number	Subject	Leader	Associate
E. 1	1	Mosquito Control: Principles Which Underlie Breeding, Flight and Attraction to Man, and Successful Practical Control and Its Results.	T. J. Headlee	M. Carroll
E. 2	2	Climate and Insect Investigations: at This Time, the Atmospheric Moisture Factor.	T. J. Headlee	
E. 3	3	Orchard Insect Investigations: at This Time, Peach Borer, Oriental Peach Moth and Codling Moth.	T. J. Headlee	A. Peterson
E. 4	4	Small Fruit Insect Investigations.	T. J. Headlee	
E. 5	5	Vegetable Insect Investigations: at This Time, Cucumber Flea Beetle, Pink and Green Aphis of Potato and Tomato.	T. J. Headlee	A. Peterson
E. 6	6	Insects Injurious to Market Milk.	T. J. Headlee	
E. 7	7	Arthropods Injurious to Poultry Production.	T. J. Headlee	
E. 8	8	Stickers, Spreaders and Dilutants for Dusting and Spraying Mixtures.	T. J. Headlee	A. Peterson
E. 9	9	Investigations of Cranberry Problems: at This Time Plant-Food Requirements of Cranberry Soil—Factors Underlying Submergence Injury—Water Table Studies—Factors Underlying Weed Control—Methods of Harvesting and Control of Fungi and Insects.	T. J. Headlee	C. S. Beckwith
E. 10	10	Investigations of the Biology of Sewage.	T. J. Headlee R. B. FitzRandolph R. O. Smith	

OYSTER SPECIALIST

Oy. 1	1	A Study of Environmental Factors in Oyster Propagation.	T. C. Nelson	

List of Projects of the New Jersey Agricultural Experiment Stations, 1920-21—Continued

DEPARTMENT OF PLANT PATHOLOGY

Station Number	Department Number	Subject	Leader	Associate
P. Path. 1	111	Studies of Fungi Injurious to Paint.	M. T. Cook	C. M. Haensler
P. Path. 2	202	Life History of *Sclerotina Cinerea.*	M. T. Cook	
P. Path. 3	221	An Investigation of the Horse Radish Root-rot.	M. T. Cook	R. F. Poole
P. Path. 4	302	Investigations of Celery Root-rots.	M. T. Cook	R. F. Poole
P. Path 5	331	Studies on Eggplant Wilt.	M. T. Cook	
P. Path. 6	441	Stimulating Influence of Bordeaux Mixture on Potato Plants.	M. T. Cook	
P. Path 7	502	Spraying Experiments on Pears for the Control of Pear Fruit and Leaf Spot.	M. T. Cook	
P. Path 8	555	Parasitism—a Comparison of the Development of Dodder and Morning Glory.	M. T. Cook	
P. Path. 9	801	Spraying for Control of Cherry Leaf Spot.	M. T. Cook	
P. Path. 10	601	Investigations of the Use of Elemental Sulfur for the Control of Scab of Irish Potato.	W. H. Martin	
P. Path. 11	602	Physiological Studies of Potato Scab.	W. H. Martin	
P. Path. 12	603	Control of Foliage Diseases of the Potato by the Application of Bordeaux Mixture.	W. H. Martin	
P. Path. 13	604	Investigations of Tuber-borne Diseases of the Potato.	W. H. Martin	

DEPARTMENT OF PLANT PHYSIOLOGY

Station Number	Department Number	Subject	Leader	Associate
P. Ph. 1	A 1-19	Salt Requirements of Representative Agricultural Plants.	J. W. Shive	W. H. Martin
P. Ph. 2	A 2-19	Relation of Soil Moisture and of the Moisture Content of Sand Cultures to Balanced Fertilizer Rations and to the Physiological Value of Nutrient Mixtures for Plants.	J. W. Shive	
P. Ph. 3	A 3-19	Relation of Non-colloidal Solid Substrata to Certain Properties of Nutrient Media for the Growth of Plants.	J. W. Shive	
P. Ph. 4	A 5-19	Seed Storage Investigations.	J. W. Shive	J. G. Fiske
P. Ph. 5	A S-20	The Relative Availability and Efficiency of Various Soluble and Insoluble Iron Compounds in Relation to Plant Production.	J. W. Shive	
P. Ph. 6	A 7-20	Study of Ammonium Sulfate in Relation to Plant Growth.	J. W. Shive	L. H. Jones

List of Projects of the New Jersey Agricultural Experiment Stations, 1920-21—Continued

DEPARTMENT OF POULTRY HUSBANDRY

Station Number	Department Number	Subject	Leader	Associate
P. H. 1	A-1-12	Amount, Distribution and Inheritance of Fecundity in the Domestic Fowl.	H. R. Lewis	E. H. Wene
P. H. 2	A 2-15	Variation In and Inheritance of Eggshell Color.	W. C. Thompson	
P. H. 3	A-3-16	Improvement of Poultry Through the Establishment of Egg-Laying and Breed-Testing Stations.	H. R. Lewis	E. H. Wene R. R. Hannas
P. H. 4	B 1-16	The Amount and Causes of Embryo Mortality.	R. R. Hannas	E. H. Wene
P. H. 5	C 1-15	The Influence of Quantity and Quality of Feed Upon Egg Production.	H. R. Lewis	R. R. Hannas E. H. Wene
P. H. 6	D 1-19	The Influence of Artificial Illumination Upon Egg Production.	H. R. Lewis	
P. H. 7	D 2-17	Poultry Flock and Farm Management Studies.	H. R. Lewis	
P. H. 8	V-A 2-19	External Characters as Indicative of a Fowl's Breeding Ability.	H. R. Lewis	E. H. Wene
P. H. 9	X 1-19	A Complete Study of Contagious Epitheliosis.	W. C. Thompson	
P. H. 10	X 2-14	Observations Concerning the Prevalence and Distribution of Poultry Diseases in New Jersey.	W. C. Thompson	E. H. Wene
P. H. 12	21-17	Methods of Preparing, Packing and Shipping Poultry and Poultry Products; Prevailing Prices and the Cause of Price Fluctuations in the Greater Markets.	G. H. Pound	

DEPARTMENT OF SEED ANALYSIS

Station Number	Department Number	Subject	Leader	Associate
S. A. 1	1	Studies of the Germination of Beet Seed.	J. G. Fiske	
S. A. 2	2	Studies of the Germination of Celery Seed.	J. G. Fiske	
S. A. 3	3	The Difference Between Mammoth Red Clover and Common Red Clover Seed.	J. G. Fiske	
S. A. 4	4	Experiments on Soil Inoculation.	J. G. Fiske	
S. A. 5	5	Studies on the Longevity of Grass and Clover Seeds.	J. P. Helyar	
S. A. 6	6	Investigations in the Drying of Agricultural Seeds for the Reduction of Moisture Content as a Preservative Measure in Storage.	J. G. Fiske	
S. A. 7	7	Best Laboratory Medium for the Germination of Corn.	J. G. Fiske	
S. A. 8	8	Disinfecting Seeds.	J. G. Fiske	

List of Projects of the New Jersey Agricultural Experiment Stations, 1920-21—Continued

DEPARTMENT OF SOIL CHEMISTRY AND BACTERIOLOGY

Station Number	Department Number	Subject	Leader	Associate
SC&B 1	1	Availability of Nitrogenous Materials Used as Fertilizers.	J. G. Lipman	A. W. Blair A. L. Prince
SC&B 2	2	Factors Underlying the Accumulation and Utilization of Atmospheric Nitrogen.	J. G. Lipman	A. W. Blair A. L. Prince
SC&B 3	3	Sulfur Oxidation by Microorganisms.	J. G. Lipman	J. S. Joffee A. L. Prince S. A. Waksman
SC&B 4	4	Potash Availability.	A. W. Blair	H. C. McLean
SC&B 5	5	Fertilizer Ratio Experiments.	A. W. Blair	W. H. Martin
SC&B 6	6	Sources and Amounts of Plant-Food in Potato Growing.	A. W. Blair	
SC&B 7	7	The Economical Use of Nitrogen in Corn Growing.	A. W. Blair	
SC&B 8	8	Soil Biology Project: A Study of Soil Actinomycetes.	J. G. Lipman	S. A. Waksman
SC&B 9	9	Borax Experiment: The Toxic Limits of Borax For Field Crops.	A. W. Blair	
SC&B 10	10	Sodium Chloride: Influence of Soil Potash—Suppression of Weeds and Insects.	W. Rudolfs	
SC&B 11	11	Weed Plots or Half Plots; The Deficiency of Nitrogen Phosphorus and Potassium as Influencing Competition Among Weeds.	J. G. Lipman	A. W. Blair A. L. Prince

DEPARTMENT OF HORTICULTURE

Station Number	Department Number	Subject	Leader	Associate
H. 1	1	Plant-Food Studies With Peaches.	M. A. Blake A. J. Farley	C. H. Connors
H. 2	2	Peach Pruning Experiments.	M. A. Blake	C. H. Connors
H. 3	3	Apple Pruning Experiments.	M. A. Blake A. J. Farley	C. H. Connors R. P. Armstrong
H. 4	4	Peach Breeding Experiment.	C. H. Connors	M. A. Blake A. J. Farley
H. 5	5	Plant Food Studies With Apples.	A. J. Farley	
H. 6	7	Apple Growth Experiments.	A. J. Farley	H. B. Seaver
H. 7	8	Investigations Upon Peach Yellows and Little Peach.	M. A. Blake	C. H. Connors
H. 8	9	Carnation Breeding Experiments.	C. H. Connors	
H. 9	10	Carnation Culture Studies.	M. A. Blake	C. H. Connors
H. 10	11	Rose Culture Studies.	M. A. Blake	C. H. Connors
H. 11	13	Plant Food Studies with Tomatoes.	L. G. Schermerhorn	
H. 12	14	Tomato Breeding Experiment.	C. H. Connors	L. G. Schermerhorn

REPORT OF THE DEPARTMENT OF CHEMISTRY

Department of Chemistry

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*Resigned Oct. 1, 1920.
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Report of the Department of Chemistry

CHARLES S. CATHCART

I. INTRODUCTORY

The activities of the department of chemistry do not vary greatly from year to year since the inspection laws of the state prescribe the work to be done and this is sufficient to require the entire time of the members of the department. In fact, the quantity of work required is so large that it could not be taken care of by the number of assistants assigned to the department unless every member devoted his full time assiduously to the analyses required. Full credit, therefore, is due each member of the department for the manner in which the work was accomplished.

II. ADMINISTRATION

During the fiscal year ending June 30, 1921, inspections of the materials sold as insecticides, fertilizers, agricultural lime and commercial feeding stuffs were made. In order to make the inspections the following details had to be considered: (1) registrations; (2) collection of samples; (3) chemical examinations; (4) reports to the purchasers and manufacturers and (5) publication of the results.

All of the inspection laws require annual registration of the brands to be offered for sale. As these registrations are submitted a record is made for use during the year and certificates are forwarded to the parties making the registrations. Inasmuch as the fertilizer and feeding stuffs laws do not permit the lowering of the standard of any brand after it has once been registered, it is necessary to keep a permanent record of each new brand registered in order that the information may be available when applications are received. The fertilizer and feeding stuffs laws also require tonnage reports to be rendered twice a year. These reports when received are recorded in their proper places for future reference.

The registrations and tonnage reports are made on printed forms supplied by the Station in order that there may be uniformity in the papers submitted, and also that the statements may be made in terms acceptable to the requirements of the laws.

The following is a summary of the applications for registrations which were received during the year 1920, and for which certificates were duly issued:

Insecticide registrations	266
Fertilizer registrations	1572
Agricultural line registrations	80
Commercial feeding stuffs registrations	2190
Total registrations	4108

During the four inspections a total of 1,980 samples were examined and reported to the manufacturers as well as to the parties whose stock was represented by the samples examined.

A summary of the results obtained during the inspections will be given in this report, but the detailed reports will be found in the bulletins 343, 344, 349, 350 and 354.

III. INSPECTION OF INSECTICIDES AND FUNGICIDES DURING 1920

The detailed results of this inspection were published under date of October 11, 1920, in Bulletin 343.

Registrations

In accordance with the requirements of the law (Chapter 89, Session of 1912), 49 manufacturers and dealers registered 266 brands which they would offer for sale.

Inspection

The collection of the samples was made by one of our regular inspectors who was given very definite instructions as to the methods to be used in drawing the samples. He was instructed also to secure, when possible, samples of the brands in original packages as well as those which represented larger shipments. In accordance with these instructions, a total of 103 samples were collected and forwarded to the Station.

Ninety-three samples were examined, consisting of—

14	samples of paris green
8	samples of lead arsenate (paste)
13	samples of lead arsenate (powder)
5	samples of calcium arsenate
11	samples of bordeaux mixture
4	samples of lime-sulfur solution
3	samples of soluble-sulfur compounds
5	samples of nicotine preparations
30	samples of miscellaneous brands
93	total

Paris Green

Fourteen samples of paris green were examined, 10 of which were received in original packages. The samples which were received in original packages were carefully weighed with and without the container in order to ascertain the net weight of the insecticide. All of these samples contained the net weight claimed, with the exception of one sample, which was supposed to contain 1 pound, but was nearly 1 ounce short in weight.

The standard for paris green as prescribed by our law is that it should contain at least 50 per cent of arsenious oxide, and that it should not contain arsenic in water-soluble forms equivalent to more than 3.50 per cent of arsenious oxide. All of the samples satisfied these requirements.

Lead Arsenate

There were 8 samples of lead arsenate paste examined. All of these samples were received in original packages; 6 samples contained the net weight claimed and 2 samples were supposed to contain 1 pound each, but their actual weight was about 2 ounces short.

The standard for this material is that it should contain (1) not more than 50 per cent of water; (2) not less than 12.5 per cent of arsenic oxide and (3) water-soluble arsenic equivalent to less than 0.75 per cent of arsenic oxide. All of the samples satisfied these requirements with two exceptions. One of the samples contained an excess of water-soluble arsenic and another sample contained a small amount of water in excess of the amount prescribed.

There were 13 samples of powdered lead arsenate, all of which satisfied the guarantees given.

Calcium Arsenate

Five samples of calcium arsenate were examined. One sample was low in the content of total arsenic and two samples contained an excess of water-soluble arsenic. The other two samples satisfied the guarantees given.

Bordeaux Mixture

A total of 11 samples of bordeaux, 8 of which were in a dry form, were examined. All of the samples satisfied the guarantees given.

Lime-Sulfur Solution and Soluble-Sulfur Compounds

Four samples of lime-sulfur solution and 3 samples of soluble-sulfur compounds were examined for the total sulfur content. Only one sample was guaranteed in terms of total sulfur and the results obtained satisfied the guarantee given.

Nicotine Preparations

These products were represented by 5 samples, one of which was not guaranteed. Three of the samples fully satisfied the guarantees stated and one sample was slightly deficient in the content of nicotine.

Miscellaneous Brands

There were 30 samples examined, which represented mixtures sold by the various manufacturers, all of which, with one exception, were accompanied by the guarantees at the time of sampling. Twenty-two of the guaranteed samples satisfied all of the guarantees as given, and 7 samples were deficient, 5 in one element and 2 in two elements. The deficiencies consisted of 2 in total arsenic content; 3 in an excess of water-soluble arsenic; 3 in the sulfur content and 1 in the content of nicotine.

IV. INSPECTION OF COMMERCIAL FERTILIZERS DURING 1920

The detailed results of the fertilizer inspection were published in Bulletin 344 under date of October 20, 1920, and in Bulletin 349 under date of December 29, 1920.

Authority for Making the Inspections

The law entitled "An Act Concerning Fertilizers," which was approved March 27, 1912, with the amendments which were approved April 12, 1919, requires the following:

1. Registration of the brand to be offered for sale.
2. Rendering tonnage reports on specified dates.
3. Inspection of the fertilizers sold and the publication of the results obtained.

Registrations

During the year 124 manufacturers and jobbers registered 1,572 brands of mixed fertilizers and fertilizer materials.

The law requires the publication of the registrations made and, in accordance with this requirement, under date of January 26, 1920. Bulletin 341 was issued, containing all of the registrations which had been received up to that date for the present fiscal year. The registrations that were received between that date and October 31, 1920, were published in Bulletin 349. The registrations that have been received for the present year were published in Bulletin 350.

Reports of Tonnage

The law requires the manufacturers or parties responsible for the sale of fertilizers in this state to render on April 1st and November 1st of each year a certified report of the tonnage sold during the preceding months. Table 1 shows a summary of the tonnage reported during the last 8 years.

Table 1

Summary of Tonnage Reports

YEAR	April Reports		November Reports		Total for the Year
	Mixed Fertilizers	Fertilizer Materials	Mixed Fertilizers	Fertilizer Materials	
	Tons	Tons	Tons	Tons	Tons
1913	87,446.91	10,303.17	51,706.28	7,204.79	156,661.15
1914	78,768.27	8,735.62	59,223.26	6,686.28	155,414.14
1915	87,052.13	7,276.45	53,288.11	5,459.28	153,075.97
1916	61,368.88	9,032.68	52,328.81	7,069.70	129,800.07
1917	86,840.44	9,146.80	74,231.13	6,264.73	176,483.10
1918	90,371.85	6,544.66	51,404.20	4,877.90	153,198.61
1919	94,463.07	6,264.86	43,594.97	5,162.15	149,485.05
1920	87,942.01	6,452.28	64,847.51	5,579.13	164,820.93

Wholesale Prices of the Essential Elements of Plant-Food for 1920

The wholesale prices of the unmixed or raw materials used in preparing the mixed fertilizers are quoted weekly in the trade journal, "The Oil, Paint and Drug Reporter." In order to express the figures given as prices per pound of actual plant-food, which is the form adopted by the experiment stations of this country, the quotations have been recalculated and tabulated for the year 1920.

The Trade Value of the Essential Elements of Plant-Food

For many years previous to 1916 it was the practice of this Station to prepare a schedule of values for use in computing the actual valuation of the fertilizers examined, but since the date mentioned conditions did not warrant making these valuations on account of the great fluctuations of the market. Prices have become more stabilized, and, although the calculations have not been made for publication this year, the following schedule was prepared for the use of the office:

	Cents per pound
Nitrogen in nitrates	24.0
Nitrogen in ammonium salts	28.0
Nitrogen, organic, in mixed fertilizers	40.0
Phosphoric acid, soluble in water	9.0
Phosphoric acid, soluble in ammonium citrate	8.0
Phosphoric acid, insoluble, in mixed fertilizer	3.0
Potash, soluble in water	15.0

Table 2

Wholesale Cost of Plant-Food Elements Per Pound in New York

MONTHS 1920	Nitrogen in Form of			Available Phosphoric Acid in Form of Acid Phosphate	Potash in Form of		
	Nitrate of Soda	Sulfate of Ammonia	Dried Blood		American Potash	Muriate of Potash	Sulfate of Potash
	cts.	cts.	cts.	cts.	cts.	cts.	cts.
January	20.00	.....	45.54	6.17	13.42	13.75	.....
February	23.22	.....	47.81	6.17	12.50	14.19	.....
March	24.57	.....	53.13	5.94	11.55	13.25	20.00
April	24.89	23.17	51.61	5.89	11.23	12.50	20.00
May	24.57	25.36	48.88	5.78	11.23	12.40	19.00
June	25.14	26.59	48.58	6.02	11.23	12.00	17.50
July	25.72	26.83	48.94	6.56	11.23	12.00	17.50
August	24.06	26.83	47.97	6.56	11.23	12.15	18.75
September	22.72	26.54	45.54	6.56	11.23	11.65	14.75
October	19.98	23.46	40.98	6.33	11.23	10.95	14.25
November	18.53	21.71	32.24	6.06	11.23	10.35	14.25
December	17.95	17.56	26.87	5.84	10.75	9.63	14.25
Average, 1920	22.61	24.23	44.84	6.16	11.51	12.07	17.03
Average, 1919	22.73	22.13	37.54	6.12	12.41	15.40	.....
Average, 1918	30.17	32 82	42.04	6.36	.....	31.02	36.33

Collection of Samples

The plan adopted for the collection of the samples was the same as used in the previous inspections, which included carefully prepared itineraries for the two inspectors who had been assigned to the work. When the time arrived to start the actual collection of the samples of spring goods, we were reminded that it was not always possible to carry out a project as it is outlined on paper. The severe winter with the late storms had made the freight deliveries late, and it had also made many of the roads impassable, so that our inspectors could not get very far from the main thoroughfares. We made every effort possible to keep track of the shipments as they arrived and secured such samples as we could during the early part of the season. After a time conditions were better and the regular work was taken up, but it is quite possible that we were unable to look after the shipments in certain localities as we had desired.

Two collections were made during the year, the first one during the spring months and the second one in September.

During these tours the inspectors visited every county in the state, and a total of 1,285 samples were received at the Station. A small percentage of these samples was forwarded by individuals who were responsible for the accuracy of the samples submitted. The official samples taken by our inspectors represented the stock of 437 dealers and consumers who were located in 168 cities or towns. The stock of many other dealers and consumers was inspected, but no samples were taken because the brands had been previously sampled at nearby places.

The unofficial samples that were forwarded by individuals were duly examined and reported, but the results are not published unless there is an apparent reason for making a permanent record of them.

Official Samples Selected for Examination

The law definitely prescribes the method to be used in the sampling of fertilizers, and the inspectors are given definite instructions regarding it. It would be impossible to examine all of the samples that could be obtained, and, consequently, the inspectors have instructions as to the number of samples of each particular brand which they should take. As a result, nearly every brand is represented by two or more samples. Every brand received is examined. If only one sample of a brand has been received there can be no selection, but when more than one sample has been received, it is our practice to select the one that represents the largest stock on hand at the time of sampling. The samples analyzed during the present year consisted of the following:

512 samples of commercial fertilizers
129 samples of commercial fertilizers (duplicates)
7 samples of home mixtures
11 samples of humus and manures
86 samples of fertilizer materials
30 samples of ground bone
123 samples of sundry materials

898 samples, total

Average Guaranteed and Actual Composition

The total number of samples of mixed fertilizers examined was 641, representing 512 brands. There were 375 brands that were guaranteed to contain nitrogen, phosphoric acid and potash, and in the other 137 brands potash was not guaranteed.

Table 3

Average of 375 Brands Containing Nitrogen, Phosphoric Acid and Potash

	Found		Guaranteed
	per cent	per cent	per cent
Nitrogen, as nitrates	0.69	....	....
Nitrogen, as ammonia salts	0.64	....	....
Nitrogen, as water-soluble organic	0.41	....	....
Nitrogen, as water-insoluble organic	0.61	....	....
Nitrogen, total	....	2.35	2.36
Phosphoric acid, total	9.80	....	....
Phosphoric acid, insoluble	1.42	....	....
Phosphoric acid, available	....	8.38	7.85
Potash	....	3.86	3.61

Table 4

Average of 137 Brands Containing Nitrogen and Phosphoric Acid

	Found		Guaranteed
	per cent	per cent	per cent
Nitrogen, as nitrates	0.57	....	....
Nitrogen, as ammonia salts	0.74	....	....
Nitrogen, as water-soluble organic	0.43	....	....
Nitrogen, as water-insoluble organic	0.77	....	....
Nitrogen, total	....	2.51	2.55
Phosphoric acid, total	12.77	....	....
Phosphoric acid, insoluble	2.26	....	....
Phosphoric acid, available	....	10.51	10.38

Tables 3 and 4 show that the average composition of the brands examined fully satisfied the average guarantees for phosphoric acid and potash, and that the average of the guarantees for nitrogen was substantially satisfied. The detailed results which are tabulated will show the exact composition of the samples examined and the variations will be clearly noted.

In order to compare the results obtained with those of preceding years, table 5 has been prepared. In preparing this tabulation, deficiencies of 0.20 per cent or less of nitrogen and 0.30 per cent or less of phosphoric acid or potash have been disregarded.

Table 5

Comparison of Deficiencies from 1910 to 1920

YEAR	Number of Brands				Deficiencies Possible	Actual Deficiencies			
	Examined	Found as Guaranteed	Found Deficient	Percentage Deficient		Nitrogen	Phosphoric Acid	Potash	Percentage
1910	520	316	204	39	1,560	51	142	45	15.3
1911	514	341	173	34	1,542	36	115	42	12.5
1912	536	326	210	39	1,608	47	146	33	14.1
1913	623	457	166	28	1,869	74	86	36	10.5
1914	608	420	188	31	1,824	63	92	49	11.2
1915	543	367	176	32	1,629	94	83	31	12.8
1916	565	356	209	37	1,406	139	81	17	16.9
1917	552	380	172	31	1,360	85	88	15	13.8
1918	502	352	150	30	1,218	82	69	15	13.6
1919	556	388	168	30	1,396	98	73	17	13.5
1920	512	340	172	33	1,399	104	61	31	14.0

The records show that 123 brands fully sustained their guarantees and that 217 brands were substantially in the same class.

In the 512 brands examined there were 1,399 deficiencies possible, and of this number 196, or 14 per cent, were found. These deficiencies consisted of the following: nitrogen, 104; phosphoric acid, 61, and potash, 31. They were distributed in 172 brands, 152 brands being deficient in one element, 17 in two elements and 3 brands in the three elements.

The percentage of deficient brands, and the percentage of actual deficiencies, are the largest that have been reported since 1912, with the exception of those for the year 1916. The figures also show that the greatest number of deficiencies are charged to the nitrogen content, which is the most costly of all of the elements. The tabulations giving the average compositions show that the average fertilizer substantially, at least, satisfied the average guarantees given, and it follows that the manufacturers delivered the total amount of plant-food called for, but the results indicate that their formulas were prepared by figuring closely to the analyses of the raw materials used, and as a result some of the mixtures exceeded their quantities while others fell short.

There is no question regarding the right of the manufacturer being paid for the materials sold, and there is also no question regarding the right and the importance of the purchaser receiving the plant-food contracted for. There is a question, however, whether there is any legitimate reason for 20 per cent of the brands being more than 0.20

per cent low in their content of nitrogen, and for 10 to 12 per cent of the brands being more than 0.30 per cent low in their content of phosphoric acid and potash. The prices for the mixtures are determined by the manufacturers and they should be so fixed that there could be no question but that the various brands would satisfy the minimum guarantee given.

Quality of Plant-Food

The laws of the various states are based upon the assumption that the essential elements of a fertilizer are nitrogen, phosphoric acid and potash, and, consequently, the guarantees are required to be stated in terms of total nitrogen, available phopshoric acid and water-soluble potash.

A knowledge of the content of available phosphoric acid and water-soluble potash gives very valuable information regarding these two elements, but the information obtained by the statement of the total nitrogen content is not sufficient, since this element may be derived from many sources, some of which are available to the growing crops, while others are at least inert for the immediate crop. It is, therefore, necessary to know the character of the materials which are used to supply this important element. In order to have this additional information, the content of total nitrogen should be determined, and also the content in the form of nitrate, of ammonia salts, of soluble and insoluble organic nitrogen, and in addition the availability of the insoluble portion should be known. The content of nitrogen derived from the first three sources is available, but the value of the insoluble portion depends upon its source or the method and completeness of its treatment.

A detailed study of the results that have been obtained this year will show that 332 brands contained nitrogen in the form of nitrates; 366 brands contained ammonia salts and 251 brands contained both of these water-soluble forms. Almost all of the brands contained water-soluble organic nitrogen, although in some cases the amount was very small. The insoluble organic nitrogen was determined in each sample, and also the availability of this form was determined. The results of these determinations show that 123, or 24 per cent, of the brands contained an inferior grade of organic nitrogen. Forty-five of these brands contained more total nitrogen than was guaranteed, and this excess was sufficient in 32 cases to offset partially the amount of inferior quality. There were 13 cases where the excess was sufficient to offset totally this condition. The percentage of brands containing inferior nitrogen is larger than that reported last year, and last year's figures were larger than those reported for the preceding year. We have repeatedly called attention to this serious condition, and it is one that should be remedied by the action of the individual buyer.

Although a fertilizer may be satisfactory as to the content of the essential elements, it may contain something that would produce a toxic effect and thus lessen, if not totally destroy, the crop. Many of the states experienced this trouble last year, and the investigations proved that one of the sources of potash carried borax in such quantities as to produce disastrous results. On account of the conditions, the Federal Government issued regulations regarding the amount of borax that would be safe, and that if an excess is present the percentage must be stated.

This Station did not issue any special ruling on the subject, but we were cooperating with the Federal Government in accordance with their ruling. The products of the different manufacturers were examined for borax, but we did not find any materials that contained a sufficient amount of this material to cause any damage. This condition was not surprising because we had information that the manufacturers were giving the question very careful attention.

Average Composition of Commercial Fertilizers

Table 6 shows the average composition of the commercial fertilizers containing nitrogen, phosphoric acid and potash, together with the average selling price, as reported during the last 10 years.

Table 6

Average Composition of Fertilizers for 10 Years

YEAR	Total Nitrogen	Total Phosphoric Acid	Available Phosphoric Acid	Insoluble Phosphoric Acid	Potash	Station's Valuation	Selling Price	Actual Difference	Percentage Difference
	per cent	per cent	per cent	per cent	per cent				per cent
1911	2.63	9.19	7.42	1.77	6.72	$22.58	$29.88	$7.40	32.8
1912	2.64	9.17	7.43	1.74	6.71	22.54	29.43	6.89	30.6
1913	2.63	9.28	7.74	1.54	7.13	23.22	29.37	6.15	20.9
1914	2.66	9.24	7.75	1.49	6.91	22.40	29.51	7.11	24.1
1915	2.70	9.78	8.19	1.59	3.54	22.11	30.95	8.84	28.6
1916	2.39	10.67	8.98	1.69	1.39	.....	32.43	....	....
1917	2.63	10.51	8.73	1.78	1.83	.....	34.35	....	....
1918	2.31	10.19	8.53	1.66	1.96	.....	46.72	....	....
1919	2.10	10.03	8.58	1.45	2.24	.....	58.73	....	....
1920	2.35	9.80	8.38	1.42	3.86	.....	53.10	....	....

Summary of the Results Obtained with the Mixed Fertilizers Examined During the Inspection of 1920

Manufacturer	Address	Number of Brands Received	Number of Samples Examined	Number of Samples Satisfied Guarantees	Number of Samples Substantially Satisfied Guarantees*	Number of Samples Deficient in—					
						Nitrogen	Phosphoric Acid	Potash	One Element	Two Elements	Three Elements
Acme Guano Co.	Baltimore, Md.	8	9	2	2	2	1	3	4	1	...
American Agricultural Chemical Co.	New York City	69	70	16	37	12	5	1	16	1	...
American Fertilizer Co.	Baltimore, Md.	5	5	....	....	5	...	1	4	1	...
American Nitro-Phospho Corporation	New York City	1	1	....	....	1	...	...	1	...	...
Armour Fertilizer Works	Baltimore, Md., and Chrome, N. J.	22	26	4	14	6	1	2	7	1	...
Baltimore Pulverizing Co.	Baltimore, Md.	2	2	1	....	....	1	...	1	...	...
Baugh & Sons Co.	Philadelphia, Pa.	21	31	10	18	2	...	1	3	...	...
Bennett & Bennett	Prospect Plains, N. J.	1	1	1	....	....	...	...	...	...	...
The Berg Co.	Philadelphia, Pa.	8	9	3	3	2	1	1	2	1	...
Bowker Fertilizer Co.	New York City	16	21	7	10	3	...	1	4	...	...
William M. Brown & Son	Cedarville, N. J.	1	1	....	....	1	...	...	1	...	...
Central Chemical Co.	Hagerstown, Md.	6	6	....	4	2	...	...	2	...	...
Chamberlain & Barclay	Cranbury, N. J.	1	3	....	3	....	...	...	...	...	...
Coe-Mortimer Co.	New York City	13	17	4	12	1	...	...	1	...	...
Collins & Son, Inc.	Moorestown, N. J.	5	5	1	2	1	1	1	1	1	...
Columbia Guano Co.	Baltimore, Md.	3	4	1	2	1	...	...	1	...	...
Consumers' Chemical Corporation	New York City	4	4	1	1	1	1	...	2	...	...
James G. Downward Co.	Coatesville, Pa.	3	3	....	....	3	3	1	...	2	1
Farmers' Co-operative Association	Trenton, N. J.	7	7	....	3	2	1	1	4	...	...
Alex. Forbes & Co.	Newark, N. J.	2	2	....	1	....	1	...	1	...	...
Godfrey Fertilizer & Chemical Co.	Newark, N. J.	9	9	2	3	2	1	1	4	...	...
Charles A. Green	Philadelphia, Pa.	6	6	....	3	1	2	...	3	...	...
Thomas Y. Hackett	Daretown, N. J.	2	2	....	1	1	...	...	1	...	...
Hendrickson & Dilatush	Robbinsville, N. J.	4	4	1	3	....	...	...	...	...	...
Heritage & Bros.	Mullica Hill, N. J.	4	4	....	2	2	...	...	2	...	...
S. M. Hess & Bro., Inc.	Philadelphia, Pa.	7	9	2	6	....	1	...	1	...	...
Thomas Hill	Flemington, N. J.	3	3	1	2	....	...	...	...	...	...
Hill Bros.	Flemington, N. J.	2	3	1	2	....	...	...	...	...	...
P. Hoffman & Bro.	Raubsville, Pa.	1	1	....	1	....	...	...	...	...	...
International Seed Co.	Rochester, N. Y.	3	3	2	....	1	...	...	1	...	...

Summary of the Results Obtained with the Mixed Fertilizers Examined During the Inspection of 1920 —Continued

Manufacturer	Address	Number of Brands Received	Number of Samples Examined	Number of Samples Satisfied Guarantees	Number of Samples Substantially Satisfied Guarantees*	Number of Samples Deficient in— Nitrogen	Phosphoric Acid	Potash	One Element	Two Elements	Three Elements
H. B. Kemp	Long Branch, N. J.	2	2	1	1	....	...	...	...	...	...
Keystone Fertilizer Co.	Philadelphia, Pa.	11	13	6	2	3	2	...	5	...	...
King Chemical Co.	Bound Brook, N. J.	3	3	2	1	....	...	...	...	...	...
Listers Agricultural Chemical Works	Newark, N. J.	24	31	10	13	....	6	2	8	...	...
Locke & Black	Swedesboro, N. J.	7	7	2	2	2	1	...	3	...	...
Mapes F. & P. Guano Co.	New York City	5	7	....	1	....	6	...	6	...	...
Martin Fertilizer Co.	Philadelphia, Pa.	9	10	1	1	8	1	1	6	2	...
Middlesex Tallow & Fertilizer Co.	Plainfield, N. J.	2	2	....	....	....	2	...	2	...	...
Monmouth County Farmers' Exchange	Freehold, N. J.	4	4	2	2	....	...	...	...	...	...
J. R. Moore	Swedesboro, N. J.	6	6	1	2	3	...	...	3	...	...
Philadelphia Guano Works	Philadelphia, Pa.	5	6	2	3	1	1	1	...	...	1
Rasin-Monumental Co.	Baltimore, Md.	14	20	6	5	7	2	2	7	2	...
Reading Bone Fertilizer Co.	Reading, Pa.	2	2	....	....	1	2	...	1	1	...
Robert A. Reichard	Allentown, Pa.	2	2	....	....	....	1	1	2	...	...
F. S. Royster Guano Co.	Baltimore, Md.	14	16	....	8	7	2	2	5	3	...
Ruckman Bros.	New Brunswick, N. J.	3	3	2	1	....	...	...	...	...	...
Schanck, Hutchinson & Field	Hightstown, N. J.	2	2	....	2	....	...	...	...	...	...
Scott Fertilizer Co.	Elkton, Md.	3	3	....	2	1	...	...	1	...	...
M. L. Shoemaker & Co., Inc.	Philadelphia, Pa.	5	5	3	....	1	1	...	2	...	...
Harry L. Sickle	Woodbury, N. J.	2	2	1	1	....	...	...	...	...	...
South Jersey Farmers' Exchange	Woodstown, N. J.	14	14	3	10	1	...	...	1	...	...
Standard Guano Co.	Baltimore, Md.	8	8	4	1	1	1	1	3	...	...
Swift & Co.	Baltimore, Md.	18	21	1	9	5	5	4	9	1	1
Swift & Co.	Harrison Station, N. J.	16	16	2	5	5	5	1	7	2	...
Taylor Bros.	Camden, N. J.	2	2	1	1	....	...	...	...	...	...
I. P. Thomas & Son Co.	Philadelphia, Pa.	18	20	3	10	3	1	3	7	...	...
Trenton Bone Fertilizer Co.	Trenton, N. J.	18	20	5	9	5	2	1	4	2	...
F. W. Tunnell & Co., Inc.	Philadelphia, Pa.	24	27	8	7	4	6	3	11	1	...
J. E. Tygert & Co.	Philadelphia, Pa.	11	11	3	6	2	...	...	2	...	...
Virginia-Carolina Chemical Co.	New York City	8	12	1	5	1	4	1	6	...	...
West Jersey Marl & Transportation Co.	Woodbury, N. J.	11	11	2	8	1	...	...	1	...	...

* Not over 0.2% low in nitrogen, 0.3% low in phosphoric acid or potash.

Ground Bone

Thirty samples of ground bone were examined during the inspection and the results are tabulated on subsequent pages.

Table 7 gives the average composition for the past 10 years.

Table 7

Average Composition of Ground Bone for 10 Years

YEAR	Fine	Coarse	Nitrogen	Phosphoric Acid	Valuation	Selling Price
	per cent	per cent	per cent	per cent		
1911	65	35	2.64	23.11	$27.31	$28.69
1912	57	43	2.99	22.89	27.73	31.12
1913	60	40	2.83	23.53	27.62	32.44
1914	60	40	2.82	23.24	29.97	32.40
1915	57	43	2.96	23.77	29.24	33.50
1916	53	47	2.80	23.80	.....	39.50
1917	58	42	2.95	24.28	.....	38.32
1918	59	41	2.85	24.84	.....	48.49
1919	58	42	2.93	24.82	.....	54.71
1920	58	42	2.97	25.06	.....	54.23

V. INSPECTION OF AGRICULTURAL LIME DURING 1920

The detailed results of this inspection were published in Bulletin 349, under date of December 29, 1920.

Registrations

During the year 1920, 33 manufacturers registered 80 different brands of agricultural lime.

Inspection

A comparatively large number of samples of the lime products were received but many of them were unofficial samples. All of these unofficial samples were examined and duly reported to the parties requesting the analyses, but the results were not included in the bulletin because we were not certain as to the accuracy of the samples.

The results obtained by the analysis of 11 samples of burned lime and of 2 samples of limestone were tabulated in the bulletin.

VI. INSPECTION OF COMMERCIAL FEEDING STUFFS DURING 1920

The detailed results of the inspection of commercial feeding stuffs were published in Bulletin 354, under date of May 2, 1921.

Authority for Making the Inspection

The law entitled "An Act Concerning Commercial Feeding Stuffs" was approved on March 28, 1912, and amendments to the law were approved on March 16, 1916, and April 11, 1919.

This law, as amended, requires:

1. An annual registration of the various brands of feeding stuffs by the person or company desiring to sell them in this state.
2. Semi-annual reports to be rendered by the parties making registrations.
3. The inspection of the feeding stuffs sold and the publication of the results.

The law also provides the penalty for any violation of its requirements.

Registrations

During the year 1920, 428 manufacturers and jobbers registered 2,190 brands which they desired to sell in New Jersey. A number of these brands were not registered, however, until they had been found by our inspectors. In most of these instances there was no legitimate reason for the condition, since the shippers admitted that the question had been overlooked. A little more attention to the registrations will result in saving the shippers and dealers some inconvenience, since our inspectors notify the dealers having unregistered stock on hand that they will be held liable for its sale.

Tonnage of Feeding Stuffs Sold

Manufacturers and those responsible for feeding stuffs sold in this state are required to render reports on July 1 and January 1 of each year, showing the total tonnage sold during the 6 months preceding these dates. Table 8 is a summary of the reports received during the past 8 years.

Inspection

The various registrations that are made are tabulated for the two inspectors who look after this work. It is the duty of the inspectors to examine the stock of the dealers and consumers and to ascertain whether the brands had been registered according to the law and to secure samples of each brand. It has been impossible to secure samples of all of the brands registered, but every brand located has been sampled and forwarded to the Station for examination.

The itineraries furnished the inspectors included every county in the state, and 1,089 samples were secured from the stock of 260 dealers and consumers who were located in 149 different cities and towns The stock of many other dealers and consumers was examined in regard to registration and the statement of the guarantees, but were not sampled because the samples had been taken of the same brands in nearby places.

Table 8

Summary of Tonnage Reports

Year	July Reports	January Reports	Total for Year
	tons	tons	tons
1913	93,664.17	102,560.00	196,224.17
1914	88,192.50	114,508.73	202,701.23
1915	103,626.91	124,563.34	228,190.25
1916	111,910.84	123,437.16	235,348.00
1917	114,939.37	119,101.06	234,040.43
1918	108,771.45	121,635.23	230,406.68
1919	102,837.34	144,052.15	246,889.49
1920	120,156.78	135,897.75	256,054.53

Results of the Examinations

During the inspection 876 of the samples collected by our inspectors were examined. These samples represented every brand collected and, in some cases, duplicate samples of the brands. In addition to these official samples, 100 samples were forwarded by individuals. These unofficial samples were examined and the reports sent to the parties interested, but the results are not tabulated in this report.

It is quite evident that the examination of this large number of samples cannot be made in a short time and this will account for the lapse of time before some of the reports are available. Each sample examined has been reported to the manufacturer responsible for the material and to the party whose stock is represented by the sample. In those samples where the sample was found to be deficient, the manufacturer was given 10 days to check the report before it was made official and sent to the purchaser.

There were 13 samples collected which were not accompanied by the required guarantees. Some of these omissions were due to the fact that they were new brands about to be put on the market and in other cases the material had been shipped in bulk and not tagged when bagged. In each case the party holding the material was notified of the necessity of attaching the information before sales were made.

The results of the examination of the 863 guaranteed samples show that 527 fully satisfied the guarantees stated and 203 samples substantially satisfied the guarantees, and that 133, or 15.4 per cent. were deficient in protein, fat or fiber. The deficiencies found consisted of the following: protein, 68; fat, 60; and fiber, 28. There were 113 brands deficient in one nutrient, 17 deficient in two nutrients and 3 deficient in the three nutrients.

A comparison of the number of deficiencies found during the last 8 inspections is given in table 9; it will be noted that this is the best showing during the period mentioned.

Table 9

Summary of Deficiencies, 1914 to 1921

INSPECTION	Samples Examined	Samples Deficient	Samples Deficient in—		
			Protein	Fat	Fiber
		per cent	per cent	per cent	per cent
1914	740	17.7	8.2	5.4	7.2
1915	920	17.2	6.7	6.8	6.6
1916	1102	26.6	9.3	9.3	14.0
1917	1103	32.3	10.0	9.3	19.6
1918	932	27.9	9.3	8.9	16.2
1919	810	22.1	9.6	4.6	12.0
1920	822	20.8	8.0	7.2	9.5
1921	863	15.4	7.9	7.0	3.3

Particular attention is called to the seriousness of some of the deficiencies found in order that the purchasers may more fully appreciate the value of the examinations.

By referring to Bulletin 354, it will be noted that the United States Feed Company, Milwaukee, Wis., sold three brands of their mixtures. A mere glance at these materials as shipped would cause a great suspicion as to the correctness of the guarantees and the results of the examinations gave evidence that the mixtures did not contain the ingredients nor the percentages of the nutrients claimed. Sale of these shipments was immediately stopped and the manufacturers were notified of the condition. After a time the manufacturers registered the materials under new brand names with guarantees suitable for the mixtures, and they prepared and forwarded tags to cover the new registrations. These feeds were not worth the prices charged for the original shipments but no information has been received whether a rebate has been paid to the purchaser.

Attention is called, also, to the character of the products sold as poultry meats. Twenty-five samples were examined, one of which was not guaranteed. Out of the 24 guaranteed samples, 13 were deficient in protein and 7 samples were misbranded, since they contained an excess of bone which was not stated in the brand names. Since these products are purchased chiefly for their high protein value, it is readily seen that the value of the material delivered is very much lower than the prices charged. These materials are sold in relatively small quantities but the total loss would undoubtedly amount to a large figure.

Selling Prices

In accordance with our practice the selling prices of the various feeding stuffs were secured, whenever possible, at the time of securing the samples in order to ascertain the average prices. Table 10 gives the average prices of several of the more important feeding stuffs as they were obtained during the last six inspections. These figures show that some of the feeding stuffs are still increasing in their cost but, taken as a whole, the prices have decreased about 4.5 per cent since the previous inspection.

Table 10

Comparison of the Average Retail Selling Prices, 1916 to 1921

FEEDING STUFF	Average Per Ton During the Inspection of					
	1916	1917	1918	1919	1920	1921
Alfalfa meal	$31.78	$32.50	$47.00	$51.00	$56.50	$53.00
Brewers' dried grains	29.25	29.41	52.80	63.80	66.20	64.50
Buckwheat feed	25.93	39.00	54.00	59.00	61.25	59.00
Buckwheat middlings.	29.00	34.00	51.22	54.40	53.40	56.00
Corn gluten feed....	30.11	36.30	59.28	58.00	74.40	67.33
Cottonseed meal	37.75	46.91	59.00	65.00	85.35	64.59
Dried beet pulp	27.25	37.00	49.25	53.00	58.33	63.42
Hominy feed	31.73	40.40	65.43	63.40	67.30	57.63
Linseed oil meal	43.38	44.12	60.07	63.80	83.45	65.07
Meat meal	57.30	58.00	96.40	109.00	105.80	116.04
Rye bran	26.33	29.57	42.80	46.80	49.90	48.33
Rye feed	32.00	33.00	43.00	49.60	69.00	63.00
Rye middlings	30.94	35.31	50.68	54.00	59.80	60.46
Wheat bran	28.16	32.30	45.37	46.40	52.14	51.19
Wheat feed	28.58	35.00	46.60	44.80	58.40	61.66
Wheat feeding flour..	37.73	41.30	68.00	57.80	75.60	77.00
Wheat middlings	33.11	38.47	57.12	50.20	65.75	63.30

Table 11 is a summary of the inspection. It shows the average composition of the various materials examined with the exception of those under the headings of brewery products, calf meal, feed mixtures and poultry feeds. The reason that the averages are not given for these classes of feeding stuffs is that since these brands have such a variable composition an average of the results would not have any particular value. The table also includes the average selling prices and the deficiencies.

In preparing the tabulation of deficiencies the protein content as found is considered to satisfy, substantially, the guarantee if it is not more than 1 per cent below it. An allowance of 0.5 per cent, also, is made for the fat and fiber content.

Table 11

Summary of the Results of the Inspection of Feeding Stuffs

	Number of Samples Examined	Average Composition				Average Retail Selling Price Per Ton	Number of Samples Satisfied Guarantees	Number of Samples Substantially Satisfied Guarantees	Number of Samples Deficient in—					
		Moisture	Protein	Fat	Fiber				Protein	Fat	Fiber	One Nutrient	Two Nutrients	Three Nutrients
		per cent	per cent	per cent	per cent									
Alfalfa meal	5	8.53	16.14	1.57	25.68	$53.00	5	......	....	....	....	....	....	....
Brewers' dried grains	16	8.19	24.93	6.86	12.97	64.50	14	......	1	1	....	2	....	....
Brewery products	5	......	......	......	......	......	5	......	....	....	....	....	....	....
Buckwheat feed	2	13.60	21.28	5.64	1.63	59.00	......	......	2	1	....	1	1	....
Buckwheat middlings	7	12.52	31.34	8.40	4.92	56.00	5	......	1	....	1	2	....	....
Buckwheat offal	2	11.45	15.97	3.80	24.78	36.50	2	......	....	....	....	....	....	....
Calf meal	3	......	......	......	......	125.50	......	2	1	....	....	1	....	....
Cocoanut meal	[1] 3	8.41	21.29	9.50	10.36	......	1	......	1	....	....	1	....	....
Cottonseed feed	2	9.14	21.96	4.11	21.52	......	2	......	....	....	....	....	....	....
Cottonseed meal	20	7.77	38.89	7.52	9.72	64.59	16	3	1	....	1	....	1	....
Corn and cob meal	7	13.46	7.84	3.57	2.97	45.20	7	......	....	....	....	....	....	....
Corn and oats	[2] 15	10.92	10.48	4.40	2.73	59.90	10	2	....	1	....	1	....	....
Corn distillers' grains	[1] 2	5.56	34.72	11.27	10.52	65.00	1	......	....	....	....	....	....	....
Corn gluten feed	11	7.99	24.31	3.48	5.99	67.33	7	3	1	....	1	....	1	....
Corn gluten meal	1	7.25	41.50	3.04	1.15	......	1	......	....	....	....	....	....	....
Dried beet pulp	[1] 9	8.58	7.18	0.60	18.07	63.42	......	6	1	1	....	2	....	....
Dried malt grains	[1] 3	4.91	21.17	6.22	17.61	66.00	1	......	....	1	....	1	....	....
Feed mixtures	237	......	......	......	......	81.17	138	66	15	23	6	25	5	3
Feed mixtures (N. J. manufacturers)	65	......	......	......	......	58.60	38	18	2	4	3	9	....	....
Fish scrap	1	6.27	38.00	2.36	[3] 18.78	......	......	......	1	....	....	1	....	....
Hominy feed	14	9.78	11.24	7.19	3.06	57.63	12	......	....	2	....	2	....	....
Linseed oil meal	13	8.65	31.21	6.75	7.89	65.07	7	3	3	....	....	3	....	....

Table 11—Continued

Summary of the Results of the Inspection of Feeding Stuffs

	Number of Samples Examined	Average Composition				Average Retail Selling Price Per Ton	Number of Samples Satisfied Guarantees	Number of Samples Substantially Satisfied Guarantees	Number of Samples Deficient in—					
		Moisture	Protein	Fat	Fiber				Protein	Fat	Fiber	One Nutrient	Two Nutrients	Three Nutrients
		per cent	per cent	per cent	per cent									
Malt sprouts	1	7.35	30.63	1.04	8.81	......	1	......	....	....	....	....	....	....
Oat feed (largely oat hulls)	2	6.09	4.85	1.89	28.59	29.00	......	2	....	....	....	....	....	....
Palmo midds.	1	8.08	16.25	6.46	7.70	57.00	......	......	....	1	....	1	....	....
Peanut oil meal	1	5.75	49.19	14.17	3.41	......	1	......	....	....	....	....	....	....
Peanut oil meal and peanut bran	2	7.51	23.13	13.72	11.23	......	1	......	1	....	....	1	....	....
Poultry feed	[1] 106	......	......	......	......	81.70	68	30	2	4	1	7	....	....
Poultry feed (N. J. manufacturers)	134	......	......	......	......	75.00	78	32	13	10	5	20	4	....
Poultry bone	1	7.50	27.00	1.11	[3] 25.14	91.00	1	......	....	....	....	....	....	....
Poultry meat	[1] 25	5.82	45.38	14.96	[3] 10.83	116.04	7	4	13	....	....	13	....	....
Rice bran	[1] 1	8.10	11.88	12.11	8.92	......	......	......	....	....	....	....	....	....
Rye bran	[1] 7	11.82	14.26	2.75	3.96	48.33	3	2	....	1	....	1	....	....
Rye feed	2	11.06	13.16	2.29	2.88	63.00	......	......	....	2	....	2	....	....
Rye middlings	[1] 10	11.57	13.72	2.97	3.52	60.46	4	2	2	1	1	2	1	....
Wheat bran	[1] 61	9.35	15.32	4.35	9.23	51.59	41	13	1	2	4	5	1	....
Wheat feed	6	9.37	16.77	4.59	7.30	61.66	4	2	....	....	....	....	....	....
Wheat feeding flour	11	9.92	16.74	4.69	2.85	77.00	7	3	1	....	....	1	....	....
Wheat middlings	[1] 60	10.16	16.26	4.65	5.54	63.30	37	10	5	5	5	9	3	....
Wheat and rye middlings	2	10.63	16.44	4.58	5.31	......	2	......	....	....	....	....	....	....

[1] One brand not guaranteed.
[2] Two brands not guaranteed.
[3] Phosphoric acid.

REPORT OF THE
DEPARTMENT OF HORTICULTURE

Department of Horticulture

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H. Gordon Bailey, *Foreman, Vegetable Growing.*

Fred. W. Jackson, B.Sc., *Assistant in Vegetable Growing.*

Clarence H. Steelman, *Orchard Foreman.*

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*Returned to Department of Horticulture on half-time April 1, 1921.
†Became Pomologist April 1, 1921.
‡Resigned November 1, 1920.

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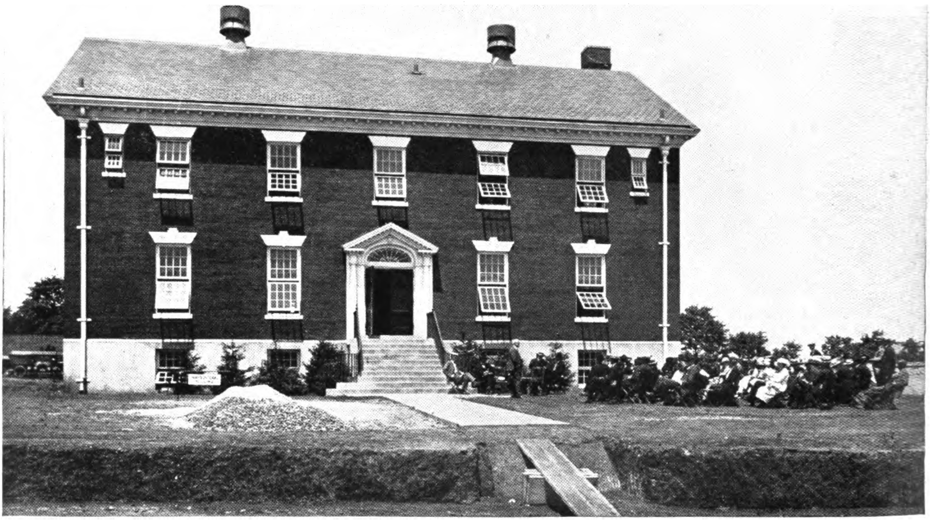
PLATE 1



DEDICATING THE NEW HORTICULTURAL BUILDING, WHICH FRUIT AND VEGETABLE MEN OF THE STATE ARE LEARNING TO THINK OF AS THEIR OWN. (FROM NEW JERSEY AGRICULTURE, JULY, 1921.)

Report of the Department of Horticulture

A. J. Farley

NEW HORTICULTURAL BUILDING

The completion of the central portion of the horticultural building during the year has provided the department with greatly improved facilities for carrying on its work. Although the building will be used primarily for instruction it also provides office and some laboratory space for members of the Experiment Station and extension staff. The acting horticulturist has been required to give a rather large amount of time during the year to details connected with the construction and equipment of the building.

ORGANIZATION OF A DIVISION OF HORTICULTURE

Prof. M. A. Blake returned to the department on April 1, 1921, on half-time and will give his full time to the horticultural work beginning July 1, 1921.

Formerly, no very definite lines of distinction were drawn in horticultural instruction and investigation between fruits, vegetables and floriculture, and one man was often a specialist in all three branches. In recent years, however, these different lines have each assumed such importance in some states that a department has been organized covering each.

The fruit and vegetable work at the New Jersey station and college has now reached such proportions in each case that it can be most efficiently administered by the organization of fruit and vegetable departments. They will be co-ordinated, however, in a so-called division of horticulture.

Such a plan is now being worked out with the return of Professor Blake to the horticultural work. Prof. A. J. Farley will head the department of pomology, and Prof. L. G. Schermerhorn the department of vegetable gardening, while floriculture will remain for the present as a part of the general work of the division.

WEATHER AND FRUIT CROP CONDITIONS

Fruit production is absolutely dependent upon favorable climatic conditions A heavy set of fruit buds in the fall does not insure a full crop of fruit the following season. Furthermore, a satisfactory set of fruit in the spring may not result in a good crop because of unfavorable climatic factors beyond the control of the fruit grower.

Favorable conditions during the spring and summer of 1920 resulted in one of the largest crops of apples and peaches ever produced in New Jersey. The fruit in general was clean, of good size and color, but only fair in quality because of the excessive rainfall. The color and finish of most winter varieties of apples were exceptional. Scab and other diseases were hard to find, notwithstanding the large amount of moisture.

Winter and Spring Weather, 1921

Conditions during the spring of 1921 were just the reverse of those during 1920. Fruit trees of all kinds were well set with fruit buds with a prospect of a crop nearly equal to that harvested in 1920. A large proportion of these buds came through the comparatively mild winter without injury, but many of them were too far advanced to withstand temperatures below freezing, such as occurred during the last week in March and early in April. The average or mean temperature during the winter and early spring months was the highest ever recorded at New Brunswick.

This was due primarily to the high temperatures during March and April, the temperature during the winter months being above normal, but not exceptional. The average or mean temperature for December, January, February, March and April during the last 10 years is shown in table 1.

Table 1

Average or Mean Temperature for December, January, February, March and April During the Last 10 Years

	1920 1921	1919 1920	1918 1919	1917 1918	1916 1917	1915 1916	1914 1915	1913 1914	1912 1913	1911 1912
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
Dec.	36.51	28.65	38.00	25.45	32.50	31.09	30.85	44.30	36.35	37.50
Jan.	34.37	23.79	34.45	30.00	31.80	36.09	33.40	28.50	39.57	21.87
Feb.	34.20	28.50	34.12	29.45	28.50	28.90	35.80	23.00	30.42	27.20
Mar.	50.06	42.20	45.52	42.45	38.50	31.20	36.80	33.80	45.10	38.10
Apr.	57.18	45.99	50.08	50.00	48.40	48.30	54.80	46.60	51.40	50.40
Average	42.46	33.82	40.43	35.47	35.94	35.11	38.33	35.24	40.56	35.01

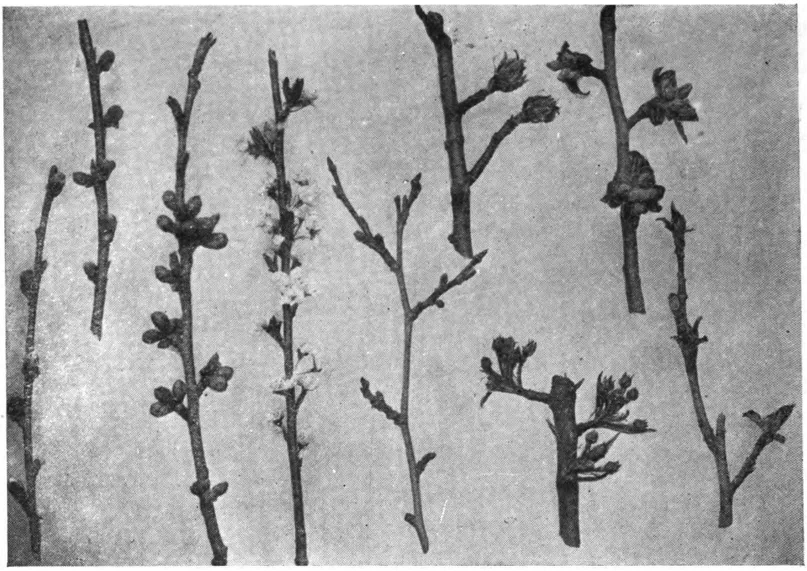


FIG. 1—FLOWER BUDS ON DIFFERENT KINDS AND VARIETIES OF FRUITS AT THE COLLEGE FARM, MARCH 29, 1921

1. ROCHESTER PEACH
2. BELLE OF GEORGIA
3. YELLOW SPANISH CHERRY
4. RED JUNE PLUM
5. FELLENBURG PLUM
6. CLAIRGEAU PEAR
7. KIEFFER PEAR
8. GRAVENSTEIN APPLE
9. SMITH CIDER APPLE

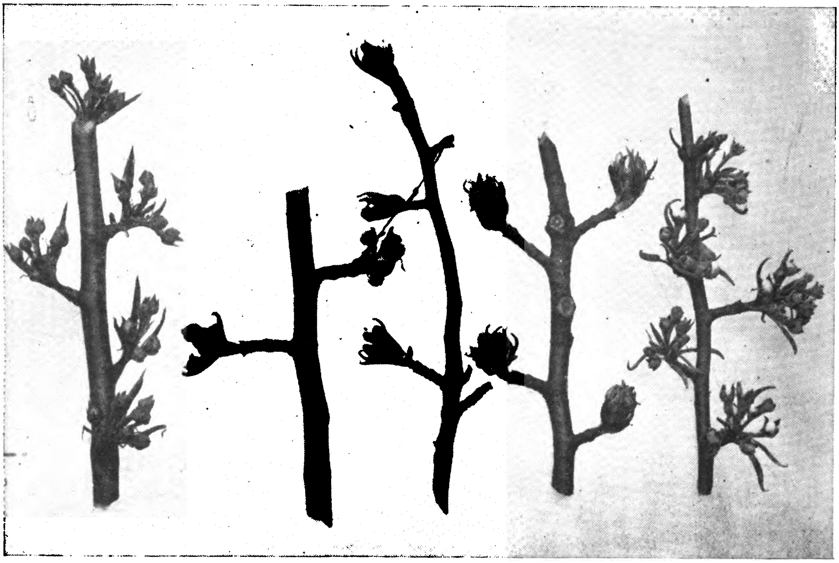


FIG. 2—PEAR BUDS AT THE COLLEGE FARM, MARCH 29, 1921

1. KIEFFER
2. BARTLETT
3. SECKEL
4. CLAIRGEAU
5. LAWRENCE

The high average for March and April is shown in table 2.

Table 2

Average or Mean Temperature for March and April During the Last 10 Years

	1920 1921	1919 1920	1918 1919	1917 1918	1916 1917	1915 1916	1914 1915	1913 1914	1912 1913	1911 1912
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
March	50.06	42.20	45.52	42.45	38.50	31.20	36.80	33.80	45.10	38.10
April	57.18	45.99	50.08	50.00	48.40	48.30	54.80	46.60	51.40	50.40
Average	53.62	43.59	47.80	46.22	43.45	39.75	45.80	40.20	48.25	44.25

Table 3

Maximum and Minimum Temperatures During the Last Two Weeks in March and the First Two Weeks in April for 1913, 1920 and 1921

	1913		1920		1921	
DATE	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
March	° F.	° F.	° F.	° F.	° F.	° F.
18	52	22	42	31	52	35
19	66	32	40	27	51	27
20	66	38	40	32	76	45
21	64	51	48	30	84	61
22	77	40	61	31	66	37
23	47	28	67	35	49	30
24	60	30	67	34	53	30
25	70	57	73	46	71	51
26	78	61	65	37	71	45
27	74	56	60	45	61	47
28	70	27	66	32	82	45
29	42	28	66	40	47	24
30	48	32	69	41	50	25
31	63	41	71	42	67	38
April						
1	68	40	71	41	65	36
2	55	39	46	39	57	27
3	60	42	61	41	71	40
4	52	42	61	40	79	44
5	68	45	48	38	79	49
6	56	33	46	29	78	47
7	46	30	46	36	73	42
8	47	29	41	27	57	42
9	50	31	43	25	71	51
10	49	28	49	29	68	38
11	52	38	53	30	50	30
12	60	45	61	33	67	32
13	60	52	61	44	71	42
14	60	50	53	34	75	49

In many ways the spring of 1921 was similar to the spring of 1913, although the latter was preceded by an exceptionally warm January, as is shown in table 1.

Effects of Freeze

The high temperatures during March, reaching a climax on the twenty-eighth with a temperature of 82, resulted in unusual activity on the part of all kinds of trees and plants. During the night of March 28 the temperature dropped to 24, a fall of 58° in less than 12 hours. The maximum on the twenty-ninth was 47°, with a minimum that night of 25°. The sudden drop on the night of March 28 resulted in very severe injury to fruit buds on all kinds of fruit trees, as well as other trees and plants. The pistils and in some cases the stamens in many fruit buds that had not started to open were killed. Several varieties of plums as well as some shrubs were in blossom at the time, as shown in the blooming-date tables. Fruit buds on peaches and cherries, and also on some varieties of pears, were almost ready to open, while buds on such varieties of apples as Gravenstein and Red Astrachan were showing considerable pink color. Among the standard varieties of plums on the College Farm it is of particular interest to note that Burbank, Abundance, Shiro, Gold and Endicott came through with a good crop of fruit.

Relative Size and Condition of Buds Upon Different Kinds and Varieties of Fruits

The abnormal weather conditions culminating in a hot, humid morning on March 28 followed by the sudden and extreme drop of 58° in temperature that night, brought out new features in the relative hardiness of tree fruits.

One generally expects the amount of injury following a freeze to be somewhat in proportion to the state of bud development and while this was true in some instances there were numerous exceptions to the rule. Japanese plums like Red June, Burbank and Abundance showed considerable bloom yet suffered less injury than some apples whose buds did not even show color.

Plate 2, figure 1, illustrates the relative size of the flower buds on several kinds and varieties of tree fruits on March 29.

Some varieties of peaches such as Rochester were ready to burst into bloom while varieties like Belle scarcely showed any pink color. European plums like Fellenburg were just beginning to show activity in comparison with Japanese types showing considerable bloom. Apples and pears ranged from a stage showing considerable pink color in the case of such sorts as Gravenstein and Duchess to the buds which barely showed green in the case of Williams.

PLATE 3

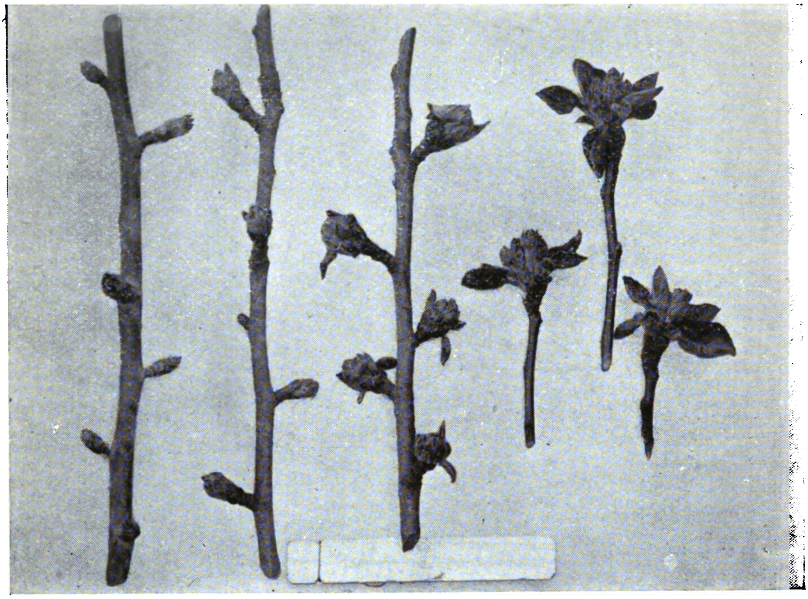


FIG. 1—TWO TWIGS AT LEFT ARE WILLIAMS; CENTER TWIG, YELLOW TRANSPARENT; THREE AT RIGHT, ASTRACHAN; AT TIME OF FREEZE, MARCH 28, 1921

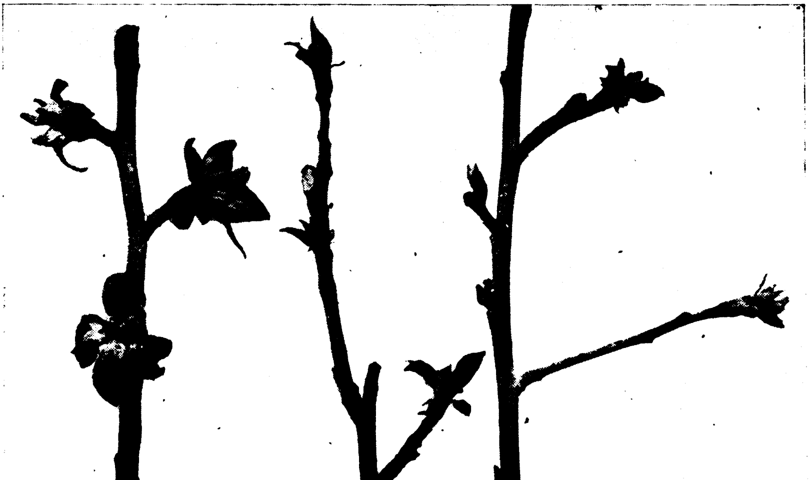


FIG. 2—BEGINNING AT LEFT, GRAVENSTEIN, SMITH CIDER AND ROME BUDS AT COLLEGE FARM AT THE TIME OF THE FREEZE, MARCH 28, 1921

Figure 2, of plate 2, illustrates the condition of the buds on 5 varieties of pears. Keiffer and Lawrence were well advanced with the buds separated in clusters, while Clairgeau was considerably less advanced.

The different varieties of apples behaved in a rather unexpected manner as a result of the freeze. As illustrated in figure 1, plate 3, Yellow Transparent was not particularly well advanced. This is also a Russian variety and one might expect that it would prove particularly resistant to cold, yet it suffered severe loss. Gravenstein, illustrated in figure 2, plate 3, was as far advanced as any variety on the station grounds when leaf and bud growth are considered, and yet withstood the cold quite successfully on the standard trees. Smith Cider proved to be one of the most resistant varieties and it was one of the less advanced on the date of the freeze. This variety also appears quite yellow and sickly at the beginning of growth each season. It seems likely that the relative succulence of the variety had much to do with the amount of injury. Varieties like Smith Cider would therefore, be expected to be resistant under the conditions which prevailed.

Spur and Axillary Buds

It is not generally recognized that many of our varieties of apples set axillary fruit buds on the 1-year-old wood growth as well as upon spurs. Varieties like Wealthy, Rome Duchess, and others, do this quite frequently in New Jersey and such buds bloom several days later than the majority of the spur buds. Some fruit growers thought they had lost their entire crop of Yellow Transparent when the spur buds were killed, and when some time later other blooms appeared, had the impression that the trees had put out a second bloom. As a matter of fact, however, these were the axillary fruit buds on the 1-year-old wood which had not been injured.

Figure 1, plate 4, illustrates the relative size of spur and axillary buds on King David at New Brunswick. The difference in the state of development between spur and axillary buds may thus be sufficient to mark the difference between injury and marked resistance.

Effect of Cold on Spurs

The great majority of the fruit buds on the various varieties of apples had hardly reached the show-pink stage of development on March 28. Where the pistils and stamens were killed, the buds immediately ceased growth, gradually turned yellow and fell from the trees or finally dried up and remained attached for a short time. Any buds in a cluster which were not injured continued their development as illustrated in figure 2, plate 4, so that within a few days after the freeze what were the smallest buds on the spurs became the largest.

The leaves also showed the results of the freeze by a characteristic wrinkling and crumpling which can also be noted in figure 2. These leaves stood out in contrast to those developed later following the cold period.

Table 4 shows the extent of the injury to fruit buds as indicated by actual counts made in the College Farm orchards. The figures represent the number of buds alive.

Table 4

Injury Caused by Freeze to Fruit on the College Farm Apples

March 29, 1921

Trees Ranging from 6 to 12 Years Old

VARIETY	Live Buds	VARIETY	Live Buds
	per cent		per cent
Stayman	57	Roxbury	17
Rome	93	Opalescent	0
Delicious	83	Westfield	26
Henry Clay	36	Gravenstein	29
Stark	35	Liveland Raspberry	40
Wilson Red June	16	Red Beitigheimer	0
Winter Banana	60	Wealthy	73
McIntosh	79	Paragon	0
R. I. Greening	63	Baldwin	0
Chenango	28	Red Astrachan	0

Trees Ranging from 25 to 35 Years Old

VARIETY	Live Buds	VARIETY	Live Buds
	per cent		per cent
King	8	Smith Cider	100
Duchess	30	Ben Davis	36
Williams	80	King David	81
Yellow Transparent	0	Winesap	100
Jonathan	74	Baldwin	20
Roxbury	76		

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100
36
81
100
20

PLATE 4

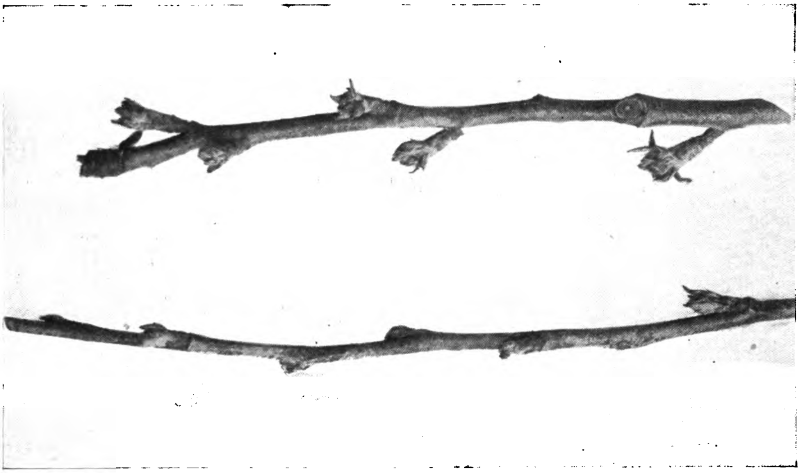

FIG. 1—KING DAVID TWIGS SHOWING RELATIVE SIZE OF SPUR AND AXILLARY BUDS

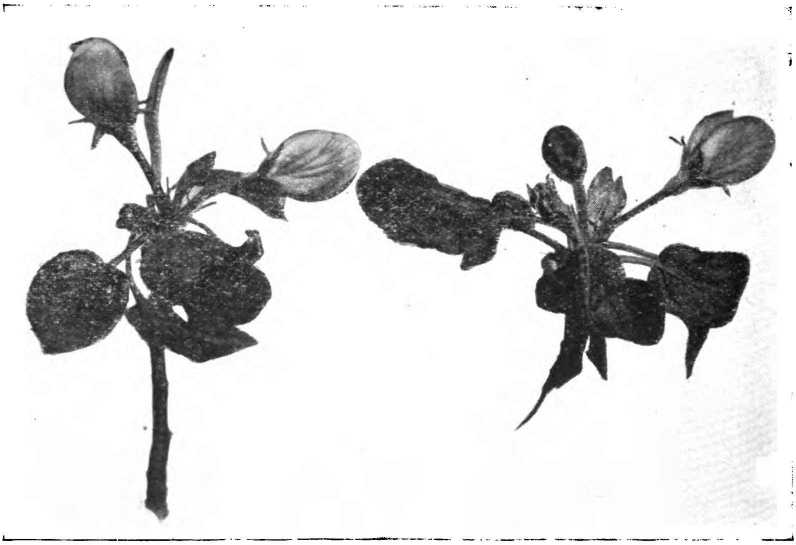

FIG. 2—THE SMALLER BUDS WHICH ARE NOT DEVELOPING ARE THE ONES INJURED

Peaches

VARIETY	Live Buds		VARIETY	Live Buds
	March 29	April 12		March 29
	per cent	per cent		per cent
Arp	83	67	Early Wheeler	18
Greensboro	50	56	Pearson	35
Carman	47	43	Slappey	60
Hiley	17	30	Japan Dream	88
Belle	40	36	Elberta (open)	26
Early Crawford	60	42	Elberta (in tent)	50
Iron Mountain	33	38		
Late Crawford	50	38		
Krummel	38	40		
Lola	86	56		

Pears, April 12

VARIETY	Live Buds	VARIETY	Live Buds
	per cent		per cent
Kieffer	23	Wilder	70
Bartlett	20	Vermont Beauty	48
Seckel	56	Lawrence	44
Clairgeau	72	Sheldon	100

All of the buds examined on Yellow Spanish, Early Richmond and Montmorency cherries on April 12 were dead.

A count made by Mr. John H. Barclay in his orchard near Cranbury, on April 1, showed the percentage of fruit buds alive given in table 5.

Table 5

Injury Caused by Freeze to Fruit on the Farm of John H. Barclay at Cranbury, N. J., and Other Places

VARIETY	Live Buds	VARIETY	Live Buds
	per cent		per cent
Fall Pippin	22	Stayman	44
R. I. Greening	46	Yellow Transparent	2
Duchess	62	Delicious	46
McIntosh	64	Ben Davis	46
Rome	80	Baldwin	12
Twenty Ounce	72	Pelican	10
Jonathan	78	Belleflower	58
Grimes	20	Walbridge	30
Wealthy	76	White Pippin	30
Cooper Redling	56	Smith Cider	100
Nero	0	Sweet Bough	96
Nyack Pippin	72	Alexander	94
Williams	92		

Percentage of buds alive in a 25-year old apple orchard near Middletown; count made on April 2.

VARIETY	Live Buds	VARIETY	Live Buds
	per cent		per cent
Paragon	9	Ben Davis	70
Twenty Ounce	77	Orange Pippin	61
Gravenstein	45	Red Astrachan	68

Percentage of buds alive in a Burlington County peach orchard.

VARIETY	Live Buds	VARIETY	Live Buds
	per cent		per cent
Fox Seedling	32	Globe	2
Elberta	10	Carman	22
Champion	8	Mayflower	24
Belle of Georgia	10	Greensboro	20

Damage Varied With Variety, Age and Vigor of Trees

As might be expected the amount of injury varied not only with the variety and kind of fruit, but with the location, age and general condition of the trees. The injury on old and comparatively weak trees was as a rule, less than that on young and very vigorous trees. Peach trees affected by borers and apple trees in sod were injured less than trees that were growing more rapidly. The same was true of apple trees injured by rabbits and mice as shown in figure 2 of plate 5. In some cases trees with a rather high percentage of injury produced a fair to good crop of fruit. For example, the Gravenstein trees in the Middletown orchard with more than half of the fruit buds killed produced a heavy crop of fruit. The same was true of some of the Duchess and Gravenstein trees in the College Farm orchard. On the other hand, Rome with a comparatively small percentage of injured buds, failed to produce a satisfactory crop, because of a very heavy June drop. The same was true of Winesap and in some cases King David produced a very light crop although apparently only slightly injured by the freeze. Among the varieties of peaches J. H. Hale came through with a good crop in many orchards where practically every other variety was a total or a partial failure.

In general it may be said that the injury was greatest in the southern part of the state, and least in the northern part. Reports from the northern counties brought out the fact that the injury to peaches, plums and pears was very slight and that the apple crop would not be reduced more than 25 per cent by the freeze. Cherries, however, were almost a total failure throughout the state, English Morello showing the least injury. The peach and pear crops were practically wiped out in the southern counties, and the same was true of many varieties of apples. Grapes, raspberries, blackberries and strawberries also were injured, the grape crop in particular being greatly reduced.

Table 6

Blooming Dates of Peaches at the College Farm, 1919, 1920 and 1921

VARIETY	1919		1920		1921	
	First	Full	First	Full	First	Full
Arp (Beauty)	....	....	5/4	5/11	4/2	....
Belle	4/10	4/14	4/30	5/10	3/28	4/5
B. G. Pratt	4/10	....	4/30	5/6	3/28	4/6
Carman	4/9	....	4/29	5/6	3/28	4/6
Chinese Cling	....	....	....	....	4/5	....
Early Crawford	4/10	....	4/25	5/4	3/28	4/5
Early Wheeler	....	....	4/29	5/7	4/2	4/5
Elberta	4/10	....	4/29	5/5	3/27	4/5
Foster	....	....	4/29	5/4	3/28	4/4
Greensboro	4/9	....	4/29	5/6	4/2	4/6
Heath	4/8	....	4/29	5/10	3/28	4/6
Hiley	4/10	4/16	4/30	5/10	3/28	4/5
Iron Mountain	4/12	....	5/1	5/12	4/3	4/6
Japan Dream	....	....	4/29	....	3/27	....
J. H. Hale	....	....	4/28	5/5	3/28	4/6
Krummel	....	....	5/2	5/10	4/3	4/6
Late Crawford	....	....	4/28	5/5	3/28	4/5
Lola	....	....	5/2	5/10	4/3	....
Pearson	4/8	....	4/29	5/6	3/26	4/4
St. John	4/10	....	4/30	5/6	4/2	4/4
Slappey	4/11	....	5/3	5/10	4/2	4/6
Triumph	....	....	....	....	4/5	....
White Blossom Single	....	....	....	....	4/4	4/6

Table 7

Blooming Dates of Apples, at the College Farm, 1921

VARIETY	First	Full	VARIETY	First	Full
Baldwin	4/11	4/20	Oldenburg	4/7	4/20
Champion	4/12	4/19	Opalescent	4/12	4/19
Chenango	4/15	4/20	Red Astrachan	4/8	4/11
Henry Clay	4/8	4/15	R. I. Greening	4/14	4/20
Delicious	4/12	4/18	Rome	4/16	4/22
Gilbert Winesap	4/10	4/21	Roxbury	4/15	4/22
Gravenstein	4/5	4/12	Stayman	4/10	4/20
Jonathan	4/15	4/22	Twenty Ounce	4/14	4/20
King	4/11	4/20	Wealthy	4/19	4/22
Lowland Raspberry	4/10	4/15	Wilson Red June	4/14	4/22
McIntosh	4/10	4/17	Winter Banana	4/13	4/21
Northern Spy	4/16	4/22	Yellow Transparent	4/10	4/19

Plate 5

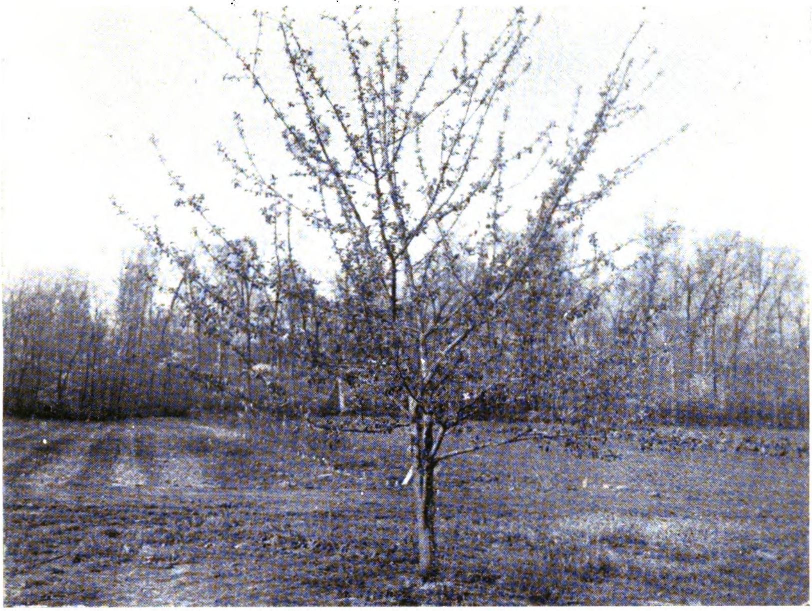

Fig. 1—A Full Crop of Blossom Buds Formed Upon This Young Stayman Apple Tree But Most of Them Were Killed by the Freeze

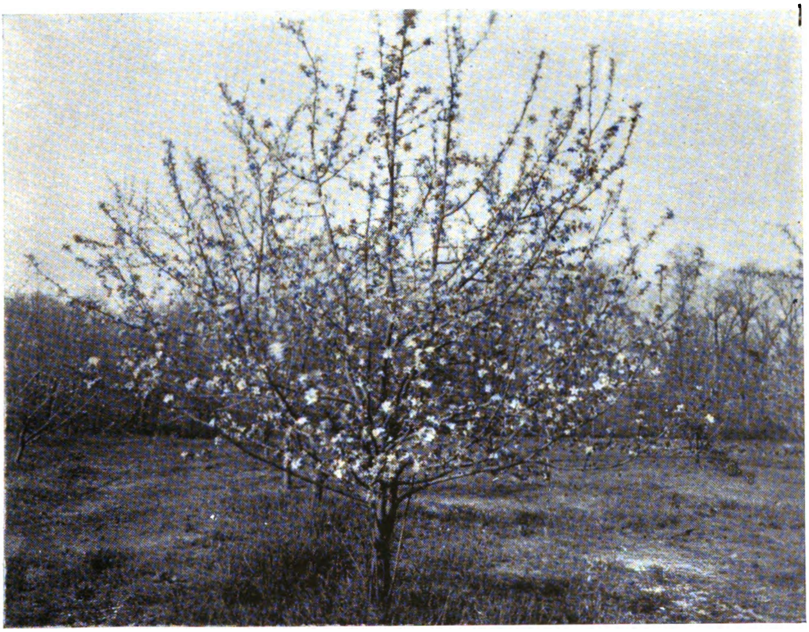

Fig. 2—Only Slight Injury Occurred to the Bloom on This Young Stayman Apple Tree Which Was Injured by Rabbits in 1919 and Bridge Grafted

Table 8

Blooming Dates of Pears at the College Farm, 1921

VARIETY	First	Full	VARIETY	First	Full
Anjou	4/4	4/8	LeConte	4/6	4/12
Bartlett	4/4	4/9	Malines	4/6	4/11
Bosc	4/8	4/13	P. Barry	4/6	4/11
Dorset	3/28	4/5	Sheldon	4/3	4/9
Clapp Favorite	4/9	4/15	Superfine	4/7	4/11
Fred Clapp	4/4	4/10	Rutter	4/6	4/12
Howell (dwarf)	4/7	4/13	Vermont Beauty	4/3	4/8
Jones Wonder	4/4	4/9	Wilder Early	4/1	4/7

Table 9

Blooming Dates of Plums at the College Farm, 1921

VARIETY	First	Full	VARIETY	First	Full
Burbank	3/24	3/30	Monarch	4/2	4/8
Chabot	3/27		October Purple	3/28	frozen
Arch Duke	4/2	4/8	Shiro	3/28	4/8
Grand Duke	4/3	4/10	Shropshire Damson	4/5	4/8
Endicott	3/28	frozen	Tokata	4/1	4/8
Fellenburg	4/2	4/9	Waneta	4/2	4/7
Gold	3/28		Wild Goose	4/3	4/11
Kahinta	4/1	4/6	Yellow Egg	4/5	4/9
Lombard	4/1	4/7	York State Prune	4/8	4/13

Table 10

Blooming Dates of Trees and Ornamentals at the College Farm, 1921

VARIETY	FIRST BLOOM	FULL BLOOM	FINAL BLOOM
Acer japonicum aconitifolium	3/30	4/8	4/15
Acer palmatum	4/9	4/14	4/20
Acer pennsylvanicum	4/16	4/21	4/28
Acer platanoides	4/9	4/14	4/18
Acer saccharinum	....	....	5/28
Aesculus carnea	5/10	5/17	6/1
Aesculus hippocastanum	5/2	5/11	5/26
Alnus glutinosa	5/14	5/18	5/21
Amelanchier canadensis	4/3	4/9	4/17
Berberis thunbergii	4/15	4/23	5/1
Berberis vulgaris	4/12	4/18	4/24
Betula alba var. *papyrifera*	4/3	4/10	4/17
Calycanthus florida	4/27	5/10	....
Celtis occidentalis	4/15	4/20	4/26
Cercis canadensis	4/7	4/14	4/28
Chionanthus virginica	5/10	5/16	5/28

Table 10 (Continued)

VARIETY	FIRST BLOOM	FULL BLOOM	FINAL BLOOM
Cornus florida var. *rubra*	4/10	4/17	5/8
Cornus mas	3/20	3/28	4/3
Cornus stolonifera flaviramea	4/28	5/5	5/15
Crataegus coccinea	4/14	4/18	5/1
Crataegus cordata	5/10	6/1	6/10
Crataegus Crus-galli	5/14	5/23	6/2
Cydonia japonica	3/28	4/4	4/20
Deutzia crenata wateri	5/10	5/25	6/2
Deutzia gracilis	4/21	5/14	6/10
Deutzia scabra	5/20	5/28	6/12
Diervilla florida candida	4/28	5/14	5/30
Diervilla florida variegata	5/1	5/12	5/20
Elaeagnus angustifolia	4/6	4/20	5/12
Evonymus europacus	4/29	5/15	5/27
Evonymus alatus	4/26	5/3	5/18
Fagus sylvatica variegata	3/20	3/28	frozen
Forsythia intermedia	3/22	3/28	frozen
Forsythia suspensa	3/15	3/22	4/4
Forsythia viridissima	3/20	3/28	4/14
Gaylussacia resinosa	4/15	4/25	5/6
Kalmia latifolia	5/15	5/28	6/13
Kerria japonica	4/16	4/28	6/1
Koelreuteria paniculata	6/27	7/5	....
Lonicera	4/19	4/25	5/15
Ligustrum ibota	5/25	5/29	6/8
Lonicera fragrantissima	3/22	3/30	frozen
Lonicera tartarica alba	4/18	4/26	5/12
Lonicera tartarica rosea	4/17	5/1	5/15
Magnolia stellata	3/23	3/28	frozen
Oxydendron arboreum	6/28	7/8	....
Philadelphus lemoinei candelabre	5/21	6/1	6/14
Prunus pseudocerasus	4/7	4/12	4/29
Pyrus (Aronia) arbutifolia	4/19	4/25	5/8
Pyrus (Sorbus) americana	4/24	4/29	5/5
Pyrus (Aronia) melanocarpa	4/18	4/25	5/5
Rhodendron catawbiense	5/11	5/15	5/19
Rhodendron maximum	5/3	5/10	5/15
Rhus canadensis	4/17	4/25	5/4
Rhus hirta	6/5	6/12	6/20
Rhus typhina laciniata	6/14	6/20	6/24
Ribes aureum	4/1	4/9	4/25
Rosa multiflora	5/16	5/22	6/5
Rosa setigera	6/20	7/1	....
Rosa rugosa	5/3	5/23	6/15
Rubus odorata	4/22	4/29	5/10
Sambucus pubens	4/13	4/18	4/25
Spirea prunifolia	3/28	4/10	5/4
Spirea thunbergii	3/26	4/2	4/17
Spirea Van Houttei	4/22	5/15	6/1
Symphoricarpos racemosus	5/24	6/3	6/28
Syringia japonica	5/25	6/1	6/10
Syringia vulgaris var. *Charles X*	5/1	5/12	5/17
Stephanandra flexuosa	5/1	5/16	5/28
Tilia americana	6/14	6/18	6/23
Vaccinum corymbosum	4/5	4/13	4/30
Viburnum plicatum	4/16	4/26	6/15

PEACH BREEDING WORK

C. H. Connors.

The peach breeding work continues to be a major project of the department. During the season of 1920, about 700 seedlings were described for the first time, and about 250 that had been described in 1919 were checked, making a total of about 950 descriptions for the season. A total of about 1,200 trees were removed during the past winter because they were not sufficiently promising.

On the basis of the 1919 crop, 66 individuals were considered promising, either from a commercial standpoint or for breeding work. Following the crop season of 1920, however, 23 of these were discarded; three trees propagated from each of the remaining 43 were planted in orchard form on the horticultural farm. These are given, by cross and by number, in table 1.

Among the seedlings that fruited first in 1920, 24 were deemed worthy of further trial and a few trees were propagated. A list of these is given in table 2.

Eighty-four seedlings resulting from the breeding work done in 1920 were planted in the nursery in the spring of 1921, and, in addition, 610 seedlings from open pollinated trees were obtained, as shown in table 3.

Table 1

Promising Seedlings propagated in 1919 and Set in the Orchard in 1921

CROSS	No. of Seedlings	Serial Numbers of Promising Seedlings			
Belle self-pollinated	7	6714	9814	15814	16714
		9414	9914	16614	
Belle X Greensboro	11	19314	23114	25714	91215
		22214	23514	87315	93915
		23014	25614	87415	
Belle X Elberta	7	26214	27914	29714	30515
		26614	29114	30314	
Belle X Early Crawford	4	32514	35114	36414	71614
Elberta, self-pollinated	5	2215	8915	12815	13315
		8115			
Elberta X Belle	3	37814	26914	30314	
Elberta X Early Crawford...	2	41514	43014		
Early Crawford X Elberta...	1	46414			
St. John, open-pollinated.....	2	51914	55314		
Late Crawford, open-pollinated	1	17914			
Total	43				

Breeding Work of 1921

An extensive program of breeding work was outlined for the spring of 1921, but, on account of delay in securing materials, the work was limited somewhat. During the breeding period, very unfavorable weather occurred. On March 25, 26, 27 and 28, the maximum temperatures were 71°, 71°, 61°, 82°, respectively, while on the twenty-ninth and thirtieth the minimum temperature reached 24° and 25°. On April 2, the minimum was 27°. Then followed 8 days of the rather high temperatures, succeeded on the eleventh and twelfth by minimums of 30° and 32°. As it is necessary in the breeding work to emasculate a large proportion of the blossoms, the pistils are left exposed to the air. The high temperatures forced a rapid development of the blossoms with a consequent high sap content in the entire tree. Succeeding freezing weather naturally was injurious to the exposed pistils. Rain, hail or snow fell on 9 of the 21 days in the breeding season. Rain falling on the exposed stigmas is apt to injure them, and, after hand-pollination, rain will frequently wash off the pollen, thus resulting in a poor set of fruits. However, where the blossoms are to be allowed to self-pollinate, they are not mutilated, so that if the pollen from the first anthers to ripen is washed off, later ripening anthers may effect fertilization, so that larger numbers of fruits are set on the self-pollinated sections.

Table 2

Promising Seedlings Propagated for Further Trial, 1920

CROSS	No. of Seedlings	Serial Numbers of Promising Seedlings			
Belle self-pollinated	2	112415	113315		
Belle X Greensboro	1	89015			
Belle X Early Crawford	1	35414			
Elberta, self-pollinated	1	1515			
Elberta X Belle	10	27115 27415 28215	29415 32615 33015	33315 33815	35215 36515
Elberta X Greensboro	2	37615	38815		
Elberta X Early Crawford	1	19915			
Early Crawford X Belle	1	63415			
Early Crawford X Elberta	3	21815	23515	26015	
Lola X Arp	1	10416			
Slappey, self-pollinated	1	43416			
Total	24				

Table 3

Peach Seedlings in Nursery

CROSS	Number of Trees
6714 (Belle S. P.) S. P.	17
6714 (Belle S. P.) X 16714 (Belle S. P.)	3
15514 (Belle S. P.) S. P.	17
15514 (Belle S. P.) X 16714 (Belle S. P.)	8
15514 (Belle S. P.) X Late Crawford	2
16714 (Belle S. P.) S. P.	12
4814 (Belle S. P.) S. P.	3
6214 (Belle S. P.) S. P.	2
6814 (Belle S. P.) S. P.	2
9814 (Belle S. P.) S. P.	7
10314 (Belle S. P.) S. P.	2
13414 (Belle S. P.) S. P.	1
35115 (Belle X Early Crawford) S. P.	2
36114 (Belle X Early Crawford) S. P.	1
36214 (Belle X Early Crawford) S. P.	1
36414 (Belle X Early Crawford) S. P.	1
12815 (Elberta S. P.) S. P.	1
17315 (Elberta X Early Crawford) S. P.	1
20815 (Early Crawford X Elberta) S. P.	1
23114 (Belle X Early Crawford) O. P.	22
27914 (Belle X Elberta) O. P.	47
46414 (Early Crawford X Elberta) O. P.	13
51914 (St. John X Carman) O. P.	114
55314 (St. John X Carman) O. P.	12
56814 (St. John X Elberta) O. P.	61
63415 (Early Crawford X Belle) O. P	22
Elberta X Early Crawford (Misc. seedlings) O. P.	119
Elberta X Greensboro (Misc. seedlings) O. P.	25
Elberta O. P.	55
Heath O. P.	5
Muir O. P.	59
Iron Mountain O. P.	56

The breeding work carried out this season was as follows, the numbered individuals being station seedlings resulting from the crosses indicated in parentheses:

Hale self-pollinated, Hale X Slappey, Hale X 26015 (Early Crawford X Elberta); Elberta self-pollinated, Elberta X 26015 (Early Crawford X Elberta), Elberta X Hale; Slappey X Elberta, Slappey X 50715 (St. John X Early Wheeler); Foster self-pollinated, Foster X Slappey Foster X 50715 (St. John X Early Wheeler); Krummel X 1515 (Elberta self-pollinated), Krummel X 6814 (Belle self-pollinated); Heath self-pollinated, Heath X Krummel, Heath X 1515 (Elberta self-pollinated), Heath X 6814 (Belle self-pollinated); St. John X 37215 (Elberta X Greensboro), St. John X 49815 (St. John X Early Wheeler), St. John X 50715 (St. John X Early Wheeler), St. John X 55916 (St. John X Greensboro); 1515 (Elberta self-pollinated) self-pollinated.

The chief object in this series of crosses is the production of early and late yellow-fleshed varieties. The seedlings used have characters as follows:

6814—Seedling of Belle self-pollinated, ripening about 10 days later than Elberta, of good quality, white of flesh but appearing to carry yellow blood.

1515—Seedling of Elberta self-pollinated, Elberta in shape and color, ripening about 2 weeks later than Elberta.

26015—Seedling of Early Crawford X Elberta, ripening about with Elberta but of better quality, yellow flesh.

37215—Seedling of Elberta X Greensboro, ripening a little earlier than Hiley, high color, good size, good quality, white flesh but appearing to carry a factor for yellow flesh.

49815—Seedling of St. John X Early Wheeler ripening with Greensboro, good quality, clingstone, white fleshed, but appearing to carry a factor for yellow flesh.

50715—Seedling of St. John X Early Wheeler, ripening about midway between Greensboro and Carman, white flesh but appearing to carry a factor for yellow flesh.

55915—Seedling of St. John X Greensboro, semi-free, ripening 4 to 5 days before Carman, white flesh but appearing to carry a factor for yellow flesh.

Most of the seedlings in the orchards have a fairly good crop of fruit, although a great many of the trees are suffering from the severe drought. Since the close of the fiscal year, rain has fallen, and the trees have improved in appearance, so that hopes are held for a good harvest.

Variety Orchard of Peaches

In connection with the breeding work, an effort has been made to assemble in an orchard all of the leading commercial varieties of peaches that are adapted to this region, varieties of former commercial importance but now of only historic interest or of use as breeding material, any seedlings that originate anywhere in the state, such of the importations of the United States Department of Agriculture, Bureau of Plant Industry, Office of Foreign Seed and Plant Introduction, as may be deemed of value in the breeding work, and such other species, types or varieties that can be grown here that may be of assistance for comparison with the seedlings, for breeding, and for a clearer interpretation of the results of the breeding work.

VARIETIES AND TYPES PLANTED

Common Varieties of Peaches

Arp (Nectar)
Belle
B. G. Pratt
Bilmeyer
Carman
Chinese Cling
Connetts
Crane's Early Yellow
Crosby
Dewey
Early Crawford
Early Elberta
Early Wheeler
Elberta
Estella
Eureka
Fitzgerald
Foster
Gold Drop
Greensboro
Heath
Hiley
Hill's Chili
Ingold
Iron Mountain
Jennie Worthen
J. H. Hale
Kalamazoo
Krummel
Late Crawford
Leamington
Lola
Lovell
Mayflower
McDevitt
Morris White
Mountain Rose
Oldmixon
Oldmixon Free
Orleans
Pearson
Phillips
Rochester
Slappey
Stevens
St. John
Stump
Tennessee Everbearing
Toughina
Triumph

Miscellaneous Seedlings and Novelties

Elberta nectarine, from Mr. Bangert, Roselle Park.
Peach (Elberta Seedling), from Mr. Tice.
Late White Peach, from Dr. Austin Scott, New Brunswick.
Paragon, from John Cassaza, Vineland.
Kathryn, from John W. Heal, Beverly.
Japan Dream.
Peen-to.
Sleeper Dwarf.

Varieties of Peaches From New Zealand

(The number given is the number of introduction, Office of Foreign Seed and Plant Introduction, U. S. Dept. Agr.)

A1	S.P.I. 43125	Motion's Cling	S.P.I. 43132
Ice Cream	S.P.I. 43126	Muir's Perfection	S.P.I. 43133
Ideal	S.P.I. 43127	Osprey Improved	S.P.I. 43134
Late Champion	S.P.I. 43129	Paragon	S.P.I. 43135
Lippiatt's Late Red	S.P.I. 43130	Shipper Cling	S.P.I. 43136
		Up-to-Date	S.P.I. 43137

Varieties of Nectarines From New Zealand

Diamond Jubilee	S.P.I. 43140	Muir's Seedling	S.P.I. 43143
Goldmine	S.P.I. 43141	New Boy	S.P.I. 43144
Lippiatt's Late Orange	S.P.I. 43142	Sure Crop	S.P.I. 43146

Other Varieties and Types of Peaches, U. S. Dept. Agr.

Chinese Bush Peach	S.P.I. 40001	Sargent's Chinese Peach Sutter Creek	S.P.I. 36125
Fei	S.P.I. 38178	Turkestan Peach	S.P.I. 24807
Mexican	S.P.I. 32374	Vainqueur (from Spain)	S.P.I. 33219

Varieties of Almonds, U. S. Dept. Agr.

Del Desmayo (from Spain)	S.P.I.33218	*Prunus Mira*	S.P.I. 34601

Apricot, U. S. Dept. Agr.

Prunus Armeniaca	S.P.I. 17154

Ornamental Varieties

Albino seedlings from wild seedling pits.

Double red flowering, *Amygdalus persica*, var. *rubra*, fl. pl. (buds from Mr. James Neilson).

Double pink flowering, *Amygdalus persica*, var. *rosea*, fl. pl. (buds from Mr James Neilson).

Double pink flowering, *Amygdalus persica*, var. *rosea*, fl. pl.

Double white flowering, *Amygdalus persica*, var. *alba*, fl. pl.

Single white flowering buds from J. L. Abbott.

PRUNING EXPERIMENTS WITH APPLES

R. P. Armstrong

The pruning experiments with apples at New Brunswick as originally outlined included a comparison of four forms of pruning with one unpruned treatment. Two types of winter or dormant season pruning and two types of summer pruning were involved. The summer pruning treatments were discontinued in 1918 and, therefore, this report covering the progress of the experiment during the past year includes only the two dormant treatments and the unpruned plot. The trees in this experiment are now 8 years old.

One lot of trees has not been pruned since planting, a second lot is thinned during the dormant season, preferably in the spring before growth starts, and a third lot is thinned and headed back from a few inches to one-half the growth of the year-old twigs during the dormant season.

In table 1 the number of trees of each variety and the treatment is indicated.

In table 2 is given the total yields, number of apples picked, the weight of picked fruit and the average weight per apple. During a severe wind and hail storm on June 29, 1920, a considerable quantity of fruit was blown off the trees and that remaining was damaged by hail.

In total yield, including fruit blown off by wind and drops, and in the quantity of fruit harvested the "not-pruned" trees have exceeded the other two treatments. In the case of Wealthy in 1920, a number of apples on the "not-pruned" trees were blown off in the storm so that the picked fruit was reduced to less than that of the thinned trees. In addition to comparisons of total yield, it is of interest to note that with all varieties the fruit from the thinned trees is larger, of far better color, freer from insect stings, fungus marks and branch rubs than the fruit from the "not-pruned" trees.

Table 1

Varieties and Number of Trees in Each Treatment

VARIETY	Thinned and Cut Back	Thinned	Not pruned
Wealthy	4	3	4
Baldwin	2	2	2
Rome	1	2	2
Delicious	5	5	5
Stayman	2	1	2

Table 2

Effect of Two Types of Dormant Pruning and no Pruning on Yield in 1920

VARIETY and TREATMENT	Average number of Fruits Blown Off	Average number of Drops	Average Total number of Apples per Tree	Average number of Picked Apples per Tree	Average Weight of Picked Apples per Tree	Average Weight per Apple
WEALTHY					pounds	ounces
Thinned and cut back	88	37	272	167	55.4	7.7
Thinned	118	79	588	351	110.1	5.0
Not pruned	220	135	666	311	96.4	4.9
BALDWIN						
Thinned and cut back	3	9	34	21	11.7	8.4
Thinned	35	21	110	54	28.1	8.2
Not pruned	76	51	295	168	87.8	8.3
ROME						
Thinned and cut back	20	11	136	105	14.7	7.5
Thinned	33	52	239	153	112.6	10.7
Not pruned	27	41	264	196	140.7	11.5
DELICIOUS						
Thinned and cut back	4	7	32	28	9.4	6.4
Thinned	19	9	59	31	11.4	5.9
Not pruned	22	51	145	72	23.4	5.2
STAYMAN						
Thinned and cut back	13	29	85	42	17.2	6.5
Thinned	40	185	264	39	13.0	5.3
Not pruned	19	93	106	94	29.6	5.0

In fact, a large percentage of the fruit from the "not-pruned" trees grades as seconds and culls, whereas, only a small portion of the apples from the "thinned" trees are so graded. The inferior quality of the apples from the "not-pruned" trees is due to the greater density of the trees. This density varies with the variety. For example, Rome, Baldwin, Delicious and Wealthy are very dense, while Stayman is more open.

In comparing the "thinned-and-cut-back," and the "thinned" treatments as to yield of fruit, the latter exceeded the former with all varieties except Stayman. The result for Stayman in the "thinned" treatment, however, is based on one tree and the difference may be due to the individuality of the tree and not the treatment.

The color of the apples borne on the "thinned-and-cut-back" trees is inferior to that of the apples produced by the "thinned" trees, since most of them are found within the top and not near the outside of the tree. The interior bearing of the "thinned-and-cut-back" trees naturally follows from the method of pruning. The cutting back removes the terminal and axillary fruit buds found on the outer vigorous shoots, which, if not pruned, would normally blossom and bear fruit on the outside of the tree. In addition the cutting back forces the growth of a number of vigorous shoots on the year-old wood, resulting in thickening the outer part of the tree and causing a shading of the interior.

The last column gives the average size of the apples. With all varieties except Rome the largest apples, on the average, have been produced by the trees in the "thinned-and-cut-back" treatment, with the next largest on the "thinned" trees. The average size of Rome for the "thinned-and-cut-back" trees was 7.5 ounces. Only one tree is included in the results and during 1920 this tree was severely affected by twig blight which may have affected the results.

The effect of the two types of pruning and no pruning on total annual shoot growth is one of the most striking results in this experiment. In table 3 is given the shoot growth made during 1919 of two trees of each variety except Stayman in the "thinned" treatment, and Rome in the "thinned-and-cut-back" treatment in which case one tree only is given. It will be noticed that in every instance the "thinned-and-cut-back" trees have greatly exceeded the "thinned- and not-pruned" trees in the amount of total twig growth.

In height there is very little difference between the same variety when compared as to treatment. The cutting back of the tops in the "winter-cut-back" trees is offset by the increased growth of the shoots causing these trees to maintain their size as compared with the other two treatments. Table 4 give the heights at the end of the season of 1920.

The trees are now 8 years old, and as a result of the pruning practices they show certain characteristics. The "not-pruned" trees are of a nondescript shape and a mass of twisted branches, and interlocking twigs. The tops are quite dense, especially with Baldwin, Rome, Stayman and Delicious, so that the centers are unproductive. With increased age these trees will be bearing largely on the periphery of the tree. Wealthy has a more open top than the other varieties. The heavy, early bearing bends the branches downward before they become rigid, thus to a certain extent, opening the top. This is particularly characteristic of Wealthy and Stayman. Nevertheless, the "not-pruned" Wealthy trees are too dense for good results and much of the fruit is wormy and inferior. Aphis flourishes, especially in the dense Rome tops. All the interior fruits of this variety were covered with honeydew and had a blackish cast.

The "thinned-and-cut-back" trees are well shaped, and have a very vigorous appearance. The chief fault with these trees is that the tops tend to become dense and require a severe thinning each spring. When fruit trees are older than 5 years it takes considerable time to prune in this manner. In the spring pruning of 1920 the average time required in pruning the 16 "cut-back" trees was 45 minutes, while the "thinned" trees averaged 16 minutes a tree.

Not only is there more thinning to do with these trees, but considerable time also is consumed in cutting back the twigs. Table 5 gives the weights of the wood removed in the different treatments. This table shows that there is usually twice as much wood removed on the average from the "thinned-and-cut-back" trees as from the "thinned" trees.

Table 3—Twig Growth, 1919

Tree Number	WEALTHY			BALDWIN			ROME			DELICIOUS			STAYMAN		
	Thinned and Cut Back	Thinned	Not Pruned	Thinned and Cut Back	Thinned	Not Pruned	Thinned and Cut Back	Thinned	Not Pruned	Thinned and Cut Back	Thinned	Not Pruned	Thinned and Cut Back	Thinned	Not Pruned
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1	12496	6868	8639	9234	10925	12169	.....	10519	6915	12156	8370	7527	14773	....	5762
2	11715	13107	6884	17983	11141	10218	16780	9202	8473	13364	7359	8864	16158	8055	6153
AVERAGE	12106	9988	7762	13609	11033	11198	16780	9860	7694	12760	7865	8196	15466	8055	5958

Figures for Rome "thinned and cut back" and Stayman "thinned" are for one tree.

Table 4—Height of Trees

Tree Number	WEALTHY			BALDWIN			ROME			DELICIOUS			STAYMAN		
	Thinned and Cut Back	Thinned	Not Pruned	Thinned and Cut Back	Thinned	Not Pruned	Thinned and Cut Back	Thinned	Not Pruned	Thinned and Cut Back	Thinned	Not Pruned	Thinned and Cut Back	Thinned	Not Pruned
	ft.	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*
1	16.0	18.0	17.0	15.5	16.0	16.5	13.5	16.0	15.0	16.0	16.0	15.0	15.5	15.0	13.5
2	16.0	15.0	16.0	17.0	16.0	15.0	....	16.0	16.0	15.0	16.0	15.5	16.0	16.0	14.5
3	16.0	15.0	16.0	....	....	....	....	....	....	16.0	16.0	16.5	....	....	....
4	15.0	....	15.0	....	....	....	....	....	....	16.0	15.0	15.0	....	....	....
5	....	....	....	....	....	....	....	....	....	15.5	14.5	16.0	....	....	....
AVERAGE	15.7	16.0	16.0	16.2	16.0	15.7	13.5	16.0	15.5	15.7	15.5	15.5	15.7	15.5	14.0

Table 5

Weight of Wood Removed in Pruning, End of Season 1919

Tree Number	WEALTHY			BALDWIN			ROME			DELICIOUS			STAYMAN		
	Thinned and Cut Back	Thinned	Not Pruned	Thinned and Cut Back	Thinned	Not Pruned	Thinned and Cut Back	Thinned	Not Pruned	Thinned and Cut Back	Thinned	Not Pruned	Thinned and Cut Back	Thinned	Not Pruned
	lbs.	lbs.		lbs.	lbs.		lbs.	lbs.		lbs.	lbs.		lbs.	lbs.	
1	29.7	11.2	....	27.5	17.2	....	....	18.7	....	29.5	10.5	....	23.2	13.5	....
2	24.2	9.5	....	34.2	18.9	....	23.5	18.7	....	27.7	11.4	....	32.8	11.5	....
3	21.0	....	....	....	....	....	....	....	....	25.5	26.0	....	....	....	....
4	10.0	....	....	....	....	....	....	....	....	24.5	13.6	....	....	....	....
5	....	....	....	....	....	....	....	....	....	25.0	17.0	....	....	....	....
AVERAGE	21.2	10.4	....	30.8	18.0	....	23.5	18.7	....	26.5	15.7	....	28.0	12.5	....

The thinned trees have been pruned to the open-head type. Each year the crowding and crossing branches have been removed and the centers opened. As a result of the pruning the tops are well opened to the light and a good distribution of fruiting wood has been obtained. These trees are now bearing fruit throughout the top. The fruit colors well and is clear and attractive in appearance. Although no heading back has been practiced the trees are quite symmetrical. In a few instances, however, a branch should have been headed back if perfect symmetry had been desired. Less time is taken in spraying these two trees than is necessary for the "not-pruned" trees. The work of harvesting can be rapidly done with the "thinned" trees, while on the other hand the "not-pruned" trees are very difficult to pick, because of the dense tops. It takes a little longer to pick the "thinned-and-cut-back" trees since the fruit is carried largely within the top which is not quite as open as in the "thinned" trees.

VEGETABLE INVESTIGATIONS

L. G. SCHERMERHORN

The fertilizer experiments with can-house tomatoes on the farm of N. B. Jones at Masonville, were continued with some changes in the fertilizer mixtures and the source of plants. Some of the fertilizer mixtures which gave the best results in 1919 were used, as were standard mixtures, some of which were home mixtures and some commercial mixtures. In addition to the comparision of fertilizer mixtures, an attempt was made to compare seedlings purchased in Burlington County with the "spotted" plants grown at the station. The results are all in favor of the spotted plants. Undoubtedly the seedling plants would have made a better showing if it had not been necessary to set them out on a very hot dry day. The "spotted" plants from the station were set on the same day.

The fertilizers were applied as in 1919, at the rate of 1000 pounds per acre; 400 pounds under the rows before ridging and 600 pounds as a side-dressing about 3 weeks after planting.

The crop was harvested in 7 pickings between August 6 and September 10, with the following results:

Average of the check plots	5.52 tons
Plot 15, first series, Experiment Station plants yielded	14.0 tons
Plot 15, second series, Burlington County plants fertilized same as on first series yielded	3.6 tons
Plot 16, first series, Experiment Station plants yielded	14.8 tons
Plot 16, second series, Burlington County plants fertilized same as on first series yielded	3.6 tons

The individual yields for 1920 are given in table 1.

Table 1

Results of Fertilizer Experiments With Tomatoes at Masonville, 1920

TREATMENT lbs. per acre.	Source of Plants Series 1 and 2	Replants		Number of plants		Yield per Acre		
		Series 1	Series 2	Series 1	Series 2	Series 1	Series 2	Average
						tons	tons	tons
Check. Nothing	Station	0	2	74	76	7.3	6.8	7.5
600 A. P., 100 KCl, 100 $NaNO_3$	Station	2	2	76	77	7.4	9.6	8.5
600 A. P., 100 KCl, 400 fish	Station	3	0	77	79	8.4	12.7	10.6
600 A.P., 100 KCl, 200 $NaNO_3$	Station	1	0	79	80	5.4	13.8	9.6
600 A.P., 100 KCl, 200 $NaNO_3$	Burlington Co.	45	27	70	68	3.9	5.2	4.5
100 KCl	Station	0	3	75	78	7.9	7.1	7.5
200 KCl	Station	3	0	80	77	7.7	5.9	6.8
Check. Nothing	Station	2	0	80	78	12.0	6.2	9.1
600 A. P., 100 KCl, 100 $NaNO_3$	Burlington Co.	33	38	67	60	2.3	2.3	2.3
600 A. P., 100 KCl, 400 fish	Burlington Co.	20	21	60	55	3.6	1.9	2.7
600 A. P., 100 KCl, 150 Sul.	Station	4	0	80	78	9.6	9.4	9.5
160 $NaNO_3$	Station	0	0	79	78	11.4	7.7	9.6
320 $NaNO_3$ 2 applications	Station	3	0	78	78	7.7	6.2	6.9
Check	Burlington Co.	22	15	61	64	3.9	2.2	3.1
600 4-8-2 (home-mixed)	* Station	4	26	77	59	14.0	3.6	* *
1000 4-8-2 (home-mixed)	* Station	2	28	79	56	14.8	3.6	* *
600 4-8-4 (home-mixed)	Station	2	1	79	77	8.7	8.4	8.6
1000 4-8-4 (home-mixed)	Station	3	0	80	79	10.3	10.9	10.6
600 4-8-6 (home-mixed)	Station	0	0	80	79	12.2	8.6	10.4
1000 4-8-6 (home-mixed)	Station	0	0	80	80	13.1	8.6	10.9
Check. Nothing	Station	0	1	74	79	9.3	3.4	6.4
1000 4-8-3 (Commercial)	Station	1	0	79	80	12.1	9.0	10.5
1000 4-8-5 (Commercial)	Station	0	2	80	80	12.5	8.4	10.5
1000 4-8-0 (Commercial)	Station	1	0	80	80	13.8	6.0	9.9

*Second series, Burlington County plants.

**Since plants were different, series cannot be averaged.

Two new fertilizer projects on tomatoes were started in the spring of 1920, one on the farm of Howard M. Sheppard at Cedarville and the other at New Brunswick.

At Cedarville, the work was along similar lines as the work at Masonville, except that different mixtures were used and the variety Greater Baltimore was used instead of Bonny Best. The results will be found in table 2.

The new set of plots at New Brunswick is a triangle, all mixtures totalling 16 units of plant food. The plots in this experiment will be set out to tomatoes for a period of several years, possibly 6 to 8 years. The plots will receive the same annual application of fertilizer, and a cover crop of rye will be plowed under each spring. The results for 1920 will be found in table 3.

In the spring of 1920, several materials were compared for the control of the cabbage maggot on early cabbage. The materials used were tar and sand, tar felt discs, and corrosive sublimate. The results were very marked and will be published in circular form at a later date.

Table 2

Fertilizer Treatments With Tomatoes at Cedarville, 1920

FERTILIZER TREATMENT PER ACRE	Number of Yielding Plants		Yield		Average
	Series 1	Series 2	Series 1	Series 2	
			tons	tons	tons
Check	79	78	7.11	6.83	6.97
100 lbs. muriate of potash	78	80	7.48	7.32	7.40
200 lbs. muriate of potash	80	80	7.33	7.75	7.54
160 lbs. nitrate of soda	80	80	5.66	7.04	6.35
320 lbs. nitrate of soda (½ at planting; ½ 4 weeks later)	80	80	7.88	9.43	8.66
400 lbs. Phos-Pho-Germ	80	80	7.48	7.43	8.45
Check	80	80	7.77	9.43	8.60
600 lbs. 2-8-2	75	71	5.26	5.37	5.32
1000 lbs. 2-8-2	78	80	4.91	8.22	6.57
600 lbs. 2-8-4	80	80	6.24	8.07	7.16
1000 lbs. 2-8-4	80	80	6.45	8.60	7.53
600 lbs. 3-8-3	80	80	7.44	8.69	8.07
1000 lbs. 3-8-3	80	80	7.62	9.23	8.43
1000 lbs. 3-8-0	80	80	6.52	6.94	6.73
600 lbs. 3-8-5	73	76	7.48	7.00	7.24
1000 lbs. 3-8-5	77	78	7.80	7.62	7.71
Check	80	80	6.64	8.65	7.65
600 lbs. 4-8-4 (home-mixed)	80	80	5.91	7.77	6.84
1000 lbs. 2-8-2 (commercial)	80	80	7.36	8.54	7.95
1000 lbs. 4-8-2 (home-mixed)	80	80	9.62	8.31	8.97
1000 lbs. 4-8-4	80	80	7.44	6.87	7.16

Experiment conducted at the farm of the Sheppard Farms Company.

Fertilizer applied at the rate of 1,000 pounds to the acre; 400 pounds under the row before ridging and 600 pounds broadcasted between the rows. Plants of the Greater Baltimore variety; grown and "spotted" at the Experiment Station at New Brunswick.

Table 3

Triangle Fertilizer Experiments With Tomatoes, Horticultural Farm, New Brunswick, N. J., 1920

FERTILIZER TREATMENT	YIELD		
	SERIES 1	SERIES 2	AVERAGE
	tons	tons	tons
Check	7.50	14.05	10.77
2-12-2	11.56	14.07	12.81
2-10-4	11.37	9.43	10.40
4-10-2	14.95	8.27	11.61
2-8-6	13.46	16.90	15.18
4-8-4	14.16	10.01	12.09
6-8-2	10.77	10.57	10.67
2-6-8	12.51	9.01	10.76
4-6-6	19.41	9.55	13.98
6-6-4	13.29	11.66	12.48
8-6-2	13.22	10.59	11.91
Check	7.70	6.12	6.91
2-4-10	15.55	14.12	14.83
4-4-8	14.92	14.05	14.49
6-4-6	16.57	12.55	14.56
8-4-4	14.90	7.84	11.37
10-4-2	17.17	11.17	14.17
2-2-12	15.15	9.06	12.10
4-2-10	12.27	10.83	11.55
6-2-8	13.42	11.16	12.29
Check	12.82	5.32	9.07
8-2-6	14.95	13.09	14.02
10-2-4	11.25	11.03	11.14
12-2-2	10.08	12.06	11.07

Fertilizer applied at the rate of 1,000 pounds to the acre; 400 pounds under the row before ridging and 600 pounds broadcasted between the rows.

Plants a selected strain of Bonny Best, grown and "spotted" at the Experiment Station at New Brunswick.

Crop harvested in 6 pickings from August 17 to September 13.

Average of the check plots .... 8.2 tons.

The original fertilizer plots at New Brunswick which were in tomatoes in 1919 were set out to Copenhagen Market Cabbage in the spring of 1920, and the yields are given in table 4.

Table 4

Results of Fertilizer Experiments on Cabbage, 1920

FERTILIZER TREATMENT	CABBAGE YIELDS			1919 TOMATOES
	Series 1	Series 2	Average	
lbs. per acre	tons	tons	tons	tons
Check	....	16.46	16.46	9.61
600 A. P.	16.13	17.28	16.70	13.88
800 A. P.	16.15	18.07	17.11	12.34
1000 A. P.	14.65	18.74	16.70	12.69
600 A. P., 100 KCl	13.82	16.02	14.92	10.90
800 A. P., 100 KCl	13.18	13.35	13.26	11.26
1000 A. P., 100 KCl	12.50	13.31	12.91	10.61
Check	14.19	13.62	13.91	6.72
600 A. P., 200 KCl	17.59	15.11	16.35	13.27
800 A. P., 200 KCl	14.17	13.61	13.89	13.02
1000 A. P., 200 KCl	11.58	11.54	11.56	11.27
800 A. P., 200 KCl, 100 $NaNO_3$	20.06	17.61	18.84	11.48
800 A. P., 200 KCl, 200 $NaNO_3$	20.05	16.58	18.32	10.79
800 A. P., 200 KCl, 150 $NaNO_3$, 37½ $(NH_4)_2SO_4$	17.35	16.16	16.76	11.72
800 A. P., 200 KCl, 100 $NaNO_3$, 75 $(NH_4)SO_4$	16.25	19.18	17.72	13.08
800 A. P., 200 KCl, 150 $(NH_4)SO_4$	17.71	15.33	16.52	12.44
800 A. P., 200 KCl, 150 $NaNO_3$, 100 Fish	14.82	16.27	15.55	8.58
800 A. P., 200 KCl, 200 Fish, 100 $NaNO_3$	12.79	14.02	13.40	10.12
800 A. P., 200 KCl, 50 $NaNO_3$, 300 Fish	15.23	18.81	17.02	11.30
800 A. P., 200 KCl, 400 Fish	17.17	17.41	17.29	9.68
Check	13.23	16.05	14.64	7.00
800 A. P., 200 KCl, 100 $NaNO_3$, 37½ NH_4SO_4, 100 Fish	14.12	17.67	15.89	9.27
800 A. P., 200 KCl, 200 $NaNO_3$				

CARNATION BREEDING

C. H. Connors.

During the past season, 144 new seedlings were grown, making a total of more than 3000 since the work was started in 1911. In addition to the new seedlings, about 70 seedlings from previous years were grown for testing and for use in the breeding work.

The breeding work continued as in previous years, promising seedlings being used mainly as parents. Considerable advancement has been made toward the securing of a desirable red variety and several are under test that seem to be superior to many that have been introduced. The progress along this line is very encouraging.

The purple carnations are still undergoing improvement. Two were secured in 1917 and since then 8 others have been obtained from seed and are now under test. Several of these are superior to the original ones.

The studies in color inheritance are still being continued. A white single has been obtained as of the third generation. Purple seedlings of the second generation also have been secured. Four red seedlings of the second and third generations are under test.

During the past year a more intensive study of variation in sex of the flowers has been begun. Various grades of sex have been established. Several individuals have been found that are perfect at one season and lose maleness at another season. At least 5 types or degrees of maleness have been established and three types of femaleness. The inheritance of these variations will be studied.

REPORT OF WEATHER OBSERVATIONS

The weather observations during the year were recorded by Clarence H. Steelman whose report follows.

The year ending June 30, 1921, was unusual, having a warm fall and a very early spring. The first killing frost occurred November 12, which is the latest on record for this locality. The monthly means for March and April were higher than ever recorded here, being 50.06° and 57.1°, respectively. The rainfall for July and August, although not heavy, was well distributed throughout the months because of the unusually large number of thunderstorms.

The winter was very mild and open, having but one heavy snowfall of 10.5 inches, which occurred February 20 and lasted one week only.

The sudden drop of the thermometer from 82° to 45° F. in less than an hour on March 28 continuing during the night to 24°, caused severe damage to fruit crops.

From May 15 to June 28 was the driest period on record, there being only 0.97 inch of rainfall in the 6 weeks. From June 1 to 28 there was only 0.23 inch of rainfall.

The mean temperature for the year was 54.97°, the highest on record. The next highest mean temperature recorded was in 1918-19, with 54.91°.

Table 2

Monthly Maximum and Minimum Means of Temperature for the Year Ending June 30, 1921

July, 1920		August, 1920		September, 1920		October, 1920		November, 1920		December, 1920	
Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
82.58	61.61	79.94	64.13	77.43	56.96	72.83	47.90	51.16	36.30	43.26	29.77

January, 1921		February, 1921		March, 1921		April, 1921		May, 1921		June, 1921	
Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
43.32	25.41	42.50	25.90	61.83	38.29	68.50	45.70	71.60	49.40	84.40	58.60

Table 1

Mean Temperature for 1920-21 Compared With Normal

	July, 1920	August, 1920	September, 1920	October, 1920	November, 1920	December, 1920	January, 1921	February, 1921	March 1921	April, 1921	May, 1921	June, 1921
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
Mean Temperature 1920–21 ...	72.09	72.03	67.19	60.36	43.73	36.51	34.37	34.20	50.06	57.10	60.50	71.51
Normal Mean Temperature ...	74.90	72.40	66.30	55.40	43.60	32.00	29.70	27.80	38.20	49.70	62.40	68.80

Table 3

Daily and Monthly Precipitation at the College Farm for the Year Ending June 30, 1921

DAY	July, 1920	August, 1920	September, 1920	October, 1920	November, 1920	December, 1920	January, 1921	February, 1921	March, 1921	April, 1921	May, 1921	June, 1921
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1	.70	.68	....	1.62	....	1.54	....	....	....	.51	.94	....
2	....	....	....	....	....	....	.01	T	....	....	....	....
3	1.51	....	....	....	.58	....	....	....	.09	....	....	....
4	....	....	....	....	....	....	....	....	....	....	.30	.03
5	....	....	....	.11	....	.80	.05	....	T	....	2.48	....
6	....	1.53	....	....	....	....	....	.01	T	....	T	....
7	....	.37	.19	....	T	....	T	....	....	....	....	....
8	.14	....	....	....	.05	....	.22	....	....	T	....	....
9	.02	....	....	....	T	....	....	.21	.18	.06	....	....
10	....	.13	.30	....	T	.10	....	....	.41	....	....	....
11	.22	.73	....	....	....	....	....	.35	....	T	....	T
12	.02	.80	.02	.09	.03	....	.02	.01	....	....	T	.04
13	.06	.14	....	....	....	.05	T	....	.63	....	1.47	....
14	....	.31	....	....	....	.95	1.68	....	....	....	.51	....
15	.11	.10	....	....	T	....	.02	....	....	.10	....	....
16	.10	.24	....	....	.22	....	....	....	T	T	.23	....
17	....	.11	....	T	1.34	T	....	....	....	.17	....	.07
18	.09	2.30	....	....	....	....	....	....	....	.31	....	....
19	.59	.01	....	....	....	....	....	....	....	.10	....	....
20	....	....	....	....	....	....	....	1.04	....	....	....	....
21	....	.01	T	....	....	....	....	.03	T	....	....	....
22	2.12	.06	....	....	.06	T	.20	.12	....	....	....	....
23	.26	.38	....	....	1.74	.84	....	....	....	.17	.07	T
24	.06	....	....	....	....	....	....	....	.14	.67	....	....
25	....	.13	.04	....	T	....	....	....	.50	....	.42	....
26	....	T	....	....	....	....	....	....	....	....	....	.09
27	....	....	....	T	....	.74	....	.38	....	....	....	....
28	....	.02	.20	.53	.01	....	....	1.44	T	....	T	.51
29	....	.11	.02	....	....	....	....	....	.05	T	....	T
30	....	....	1.46	....	....	....	.10	....	....	.25	.02	1.18
31	....	.05	....	....	....	....	.33	....	.28	....	....	....
Total	6.00	8.21	2.23	2.35	4.03	5.02	2.63	3.59	2.28	2.34	6.44	1.92
Normal	6.42	5.75	3.97	4.11	3.30	3.74	3.28	3.61	4.08	3.45	3.72	3.33

T—Trace.

REPORT OF THE DEPARTMENT OF ANIMAL HUSBANDRY

DEPARTMENT OF ANIMAL HUSBANDRY

Frank G. Helyar, B.Sc., *Animal Husbandman.*

William C. Skelley, B.Sc., *Assistant Animal Husbandman.*

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Report of the Department of Animal Husbandry

Frank G. Helyar

The department of animal husbandry has been occupied during the year with the following program:

I. Extension Activity.
II. Experimental Work.
III. Herd Development.

EXTENSION ACTIVITY

The extension work of the department is carried on almost entirely by correspondence, there being no extension specialist in animal husbandry and no funds appropriated for extension travel.

Inquiries and visits from farmers in the state showed interest predominating in disease control, swine feeding problems looking especially to sources of cheaper feeds and the possibilities of beef raising in New Jersey. Interest in sheep raising, which was quite marked during the war, fell off decidedly with the drop in the price of wool. The feeding of city garbage to swine, which was the subject of considerable inquiry during the past 3 years, seems to be of less interest.

EXPERIMENTAL WORK

Experimental work was conducted on two projects during the season of 1920:

I. A study of Buttermilk Products as Supplements to Grain and Tankage in Swine Feeding.
II. A study of the Effect of Pumpkins and Pumpkin Seed Fed to Swine.

The second project was conducted by Benjamin Masurovsky, a senior in Rutgers College taking advanced work in animal nutrition. The data will be published during the summer of 1921 in the Journal of Agricultural Research.

A Study of Buttermilk Products as Supplements to Grain and Tankage in Swine Feeding

This experiment was started June 15 and completed October 24.

Object of the Experiment

The objects of the experiment were as follows:

1. To determine the efficiency and economy of feeding buttermilk products as a supplement to grain, tankage and forage.
2. To study the relative efficiency of different amounts of buttermilk in the ration.

Plan of Experiment

Buttermilk Products. Two products were used, semi-solid buttermilk and Milkolene. The manufacturers of Ton-Gors powdered buttermilk were asked to submit plans for feeding their product but refused, as they did not believe in the use of self-feeders.

Animal Units. Four lots of 10 pigs each from April litters were carefully chosen with respect to size, vigor and breed.

Pasture. Each of these lots of pigs on June 15, 1920, was put into a half-acre pasture seeded with 5 pounds of Dwarf Essex Rape and 6 pounds of white sweet clover, each pasture receiving the same treatment as to time and method of planting and quantity of fertilizer used.

Grain Ration. All four lots were fed until July 15 on the same grain ration of corn, standard middlings and 60 per cent digester tankage fed in a self-feeder. During the trial each lot received this same ration fed in the same way.

Lot Treatment. No. 1. Check, pasture, and shelled corn, standard middlings and tankage in self-feeder.

No. 2. Same ration as No. 1, plus semi-solid buttermilk in daily amounts equal to 20 per cent of the grain being consumed daily, this percentage being that recommended by the manufacturers.

No. 3. Same as No. 1, plus semi-solid buttermilk fed in varying amounts in 3-week periods during the trial. Beginning with the first 3 weeks' period an amount equal to 10 per cent of the grain ration was fed, the second period 20 per cent, the third period 30 per cent, and the fourth period 40 per cent.

No. 4. Same as No. 1, plus Milkolene in daily amounts equal to 1 part by volume to 49 parts of water, the water used being equal to the normal water requirements of the pigs at their age as determined by Dietrich.

The semi-solid buttermilk was diluted with water 1 to 8.

Salt and mineral mixture were kept before all lots alike.

The pigs were weighed by groups every 5 days throughout the trial except that 8 of these weighings including the initial and final, the group weight was determined by adding the weights of each individual in the respective lots.

The feed, corn, middlings and tankage was weighed into the hoppers of the self-feeders at 10 o'clock each morning after taking from the hoppers and weighing food unconsumed from the previous day's allotment, the object being to prevent waste, to determine grain consumption for the purpose of calculating the amount of semi-solid buttermilk to feed and to compare the amounts of grain being used by the different lots throughout the trial.

Results of Trial

Health of the Animals

The animals in all four lots with two exceptions appeared to be strong and healthy throughout the trial. Two pigs died after a very short illness from what appeared on post mortem to be bowel impaction; one in lot 1 on October 8, and one in lot 2 on September 14. The weights of these animals being known are included in the following tables and their performance averaged in for the time they were on trial.

As far as could be determined all lots pastured their forage with equal efficiency.

Great care had to be used in handling the semi-solid buttermilk to prevent spoiling. The method used was to cover the surface of the product with water to the depth of 2 or 3 inches.

It was found that it took about 3 days for the pigs in lot 4 to get accustomed to the taste of Milkolene.

Table 1 shows the weights of pigs, initial and final, total gains, average daily gains, grain consumed and amount of the various feeding stuffs per 100 pounds of grain.

Table 2 shows the cost of the feeding stuffs fed, the cost of 100 pounds and of 1 pound of gain, and the comparison of the time necessary for each lot to make the same gain.

Conclusions

Apparently there was no difference in the appearance and general health between those pigs having buttermilk products and those not having them.

Those having buttermilk ate more food, made larger average daily gains and, therefore, were ready for market ahead of those not receiving buttermilk.

A pound of gain cost more with those pigs fed buttermilk, so much more that with the present narrow margin of profit in pork production the economy of feeding buttermilk products to market stock at the present prices of buttermilk products is questionable, at least for the entire feeding period. The only possible economy might be in the fact that the pigs are ready for early market which many times pays a premium or, that fed during the early weeks of the feeding period young pigs would get an impetus of growth that would carry them to an earlier finishing time with larger daily gains as has been proven with the feeding of skim milk.

Semi-solid buttermilk fed in an amount equal to 20 per cent by weight made no difference in the consumption of tankage, animal food, but when the amount was increased to 30 and 40 per cent to the pigs in lot 3 there was a decided decrease in the amount of tankage eaten and at the same time an increase in the amount of daily gain over that attained by the pigs receiving only 20 per cent of semi-solid buttermilk. With both materials at the same price the question as to substituting the buttermilk product for digester tankage might be worthy of consideration.

When fed with digester tankage in the ration, 20 per cent of semi-solid buttermilk was more economical than larger amounts.

Unless considerable care is used in handling the buttermilk products through the summer months there is considerable spoiled, thus involving larger feeding cost.

College Farm Durocs on Rape Pasture in June.

Table 1

Weights of Pigs in Feeding Test and Feed Consumed, 10 Pigs in Each Lot, July 16-October 24, 100 Days' Trial

	Lot 1*	Lot 2†	Lot 3	Lot 4
	lbs.	lbs.	lbs.	lbs.
Initial weight	553.00	546.00	604.00	657.00
Final weight	1651.00‡	2000.00‡	2047.00	1896.00
Total gain	1098.00	1454.00	1443.00	1239.00
Average daily gain	1.02	1.50	1.44	1.23
Feed consumed				
Corn, shelled	3959.50	4702.00	4638.00	4534.00
Middlings, standard	34.00	38.00	52.00	87.00
Tankage, 60 per cent digester	241.25	252.00	196.00	237.00
Semi-Solid Buttermilk	....	891.36	1203.15	....
Milkolene	....	....	....	99.68
Total Feed	4234.70	5883.40	6089.15	4958.20
Total feed for 100 lbs. gain	385.50	404.60	421.90	400.10
Corn for 100 lbs. gain	360.60	324.70	321.40	365.90
Middlings for 100 lbs. gain	3.09	2.61	3.60	7.06
Tankage for 100 lbs. gain	21.90	17.30	13.50	19.10
Semi-Solid Buttermilk for 100 lbs. gain	....	61.30	83.30	....
Milkolene for 100 lbs. gain	....	....	....	8.04

*One died October 8.
†One died September 14.
‡Last weight of pigs dying included.

Table 2

Cost of Feeds in Feeding Experiment

	Lot 1	Lot 2	Lot 3	Lot 4
Cost of Food—				
Corn	$126.70	$150.46	$148.41	$145.08
Middlings	1.09	1.27	1.66	2.80
Tankage	13.27	13.86	10.78	13.04
Semi-solid buttermilk	....	49.02	66.17	....
Milkolene	....	....	....	13.76
Total cost of food	141.06	214.55	227.02	174.69
Cost per 100 lbs. of gain	12.85	14.75	15.73	14.00
Days necessary to make total gain of lot 2	34.09	....	.76	17.50

Shelled corn, $64.00 per ton.
Standard middlings, $64.00 per ton.
60 per cent. digester tankage, $110.00 per ton.
Semi-solid buttermilk, $5.50 per cwt.
Milkolene, $13.80 per cwt.

HERD DEVELOPMENT

There are at the present time 108 individuals in the herd of swine divided as follows:

Duroc-Jerseys
- 1 Aged boar.
- 1 Senior boar pig.
- 2 Spring boar pigs.
- 10 Aged sows.
- 7 Open gilts.
- 26 Spring gilts.
- 17 Spring barrows.
- 7 Fall barrows.
- 3 Suckling pigs.

Berkshires
- 1 Aged boar.
- 6 Aged sows.
- 5 Spring gilts.
- 5 Spring barrows.
- 1 Grade sow.
- 3 Grade gilts.

Hampshires
- 1 Yearling boar.
- 2 Gilts.

Cross-Bred
- 2 Barrows, fall.
- 7 Barrows, spring.

Health of the Herd

The health of the herd has been, with minor exceptions, unusually good. There has been no indication of cholera since July, 1919. All pigs have been inoculated by the simultaneous serum-virus method on reaching a weight of about 50 pounds.

Breeding Work

It has been definitely proven that the pig that has the inherent characteristics of large frame, quick growth and quality makes the most profitable market pig. The demand for handy butchers, pigs in fine finish weighing from 150 to 175 pounds has resulted in many of the leading breeders of swine breeding their animals to a type that is short, compact and fine in bone. While finishing into a nice carcass these animals are not as economical of time or feed as animals with more length and height and of stronger bone and vigor. The Duroc-Jersey swine at the College Farm have tended to the compact type and inasmuch as breeding stock was being sold over the state, injustice was being done the farmers and the breed. Consequently, all sales of breeding stock have been suspended and will be until animals of the proper type are available. At the same time definite steps for the improvement of the herd have been taken through the introduction of a system of line breeding, involving the use of boars of larger type and greater vigor.

In the fall of 1919 a boar was secured through J. M. Hunter of Annandale. This boar is a line-bred Orion Cherry King by his sire and a line bred Colonel through his dam. The boar has excellent scale, good bone and quality. His progeny have now developed to the point where it can be seen that improvement has already been made. Negotiations are now under way for a boar of similar breeding to be used on the daughters of the present herd boar.

No breeding work will be attempted with other breeds, as these will be maintained largely for instruction work in the college.

NEEDS OF THE DEPARTMENT

As has been stated in previous reports the Experiment Station stands in vital relation to the food production of the state. With the trend of meat production eastward the Experiment Station should be ready to advise as to what should be the practice and methods of livestock production in New Jersey. The Experiment Station should have, in cooperation with the College, adequate barns for sheep and beef cattle and a flock and a herd of these animals. It should also have adequate funds for the maintenance of cooperative work with farmers in the state in the raising of beef cattle and sheep.

Costs of production of livestock, use of pure-bred stock, and utilization of waste materials from general and specialized farm practice, are important questions in a livestock program for New Jersey. The discussion of these problems from the standpoint of either research or extension cannot be adequate, or even hardly approached, unless there be an extension specialist in animal husbandry.

REPORT OF THE DEPARTMENT OF POULTRY HUSBANDRY

DEPARTMENT OF POULTRY HUSBANDRY

HARRY R. LEWIS, M.AGR., *Poultry Husbandman.*

WILLARD C. THOMPSON, B.SC., *Assistant Poultry Husbandman.*

*__RALSTON R. HANNAS__, B.SC., *Assistant in Research.*

GEORGE H. POUND, B.SC., *Assistant in Research.*

ELMER H. WENE, *Superintendent of Egg-Laying Contests.*

†**WILLIAM P. THORPE, JR.**, B.SC., *Temporary Assistant in Research.*

§**JOHN R. SAPPINGTON**, *Foreman, Vineland Contest.*

¶**WILLIAM L. PALMER**, *Foreman, Bergen County Contest.*

MORRIS SIEGEL, *Foreman, Station Plant.*

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*Resigned October 1, 1920.
†Appointed July 1, 1921.
§Appointed October 1, 1920.
¶Appointed November 1, 1920.

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Report of the Department of Poultry Husbandry

Harry R. Lewis

INTRODUCTION

The work of the department of poultry husbandry has progressed very satisfactorily during the past year in spite of the serious handicaps due to changes in the research staff and to illness. With one exception, all of the standard research projects of the department have been continued; no new work has been entered into; some of the projects curtailed during the war have been advanced to a full-time schedule and are progressing toward permanent conclusion. The cost of production is gradually diminishing, especially items of feed and supplies, so that we have been able to continue the research projects of the department with the funds available. Along with the decreased cost of production, there has been a decreased production in revenue through a much lower price received for the products produced. The margin of profit has remained throughout the reconstruction period eminently satisfactory to the production end.

ADMINISTRATION

During the past year, numerous changes have taken place in the departmental staff. Ralston R. Hannas, for two years assistant in research, resigned to accept a position of responsibility at the Red Cross Hospital for the Blind at Baltimore, Maryland; his appointment was temporarily filled by William P. Thorpe, Jr. Victor G. Aubry, for 5 years extension specialist, resigned to enter the commercial field. His position was immediately filled by Irving L. Owen, a graduate of Rutgers having a wide experience as county agent and manager of the University Farm. Mr. Owen ably filled this position for a period of 6 months, when he was asked to accept greater responsibility as state leader of farm demonstration. Willard H. Allen was appointed to the position April 1, 1921.

Prof. Willard C. Thompson has been absent from his duties in the department during a considerable portion of the past year, on account of critical illness. In his absence, Prof. George W. Hervey, who graduated from Rutgers in 1915 and has since been connected with the University of Missouri, was engaged to take over his responsibilities.

Weekly and monthly staff meetings have been held more or less regularly throughout the year, at which the research and administrative problems of the department are discussed and worked out. A regular order of business is followed at these meetings which results in very definite benefits to the members of the staff and to the more complete and efficient administration of the work.

CORRESPONDENCE

As in the past, each year sees a greater and greater demand made upon the department for advice and help through correspondence. As the department's activities become more widely known and the range of service which the department is able to give becomes wider, the mass of inquiries continue to become more and more a burden on the time and finances of the department. The inquiries cover a great range of subject matter and are of a wide geographical range, including many foreign correspondents, as well as isolated instances from every state in the Union. During the past year 121,117 letters have been issued by the poultry staff, divided as follows:

Administrative	4,447
Extension letters by others other than Extension Specialist	2,500
Extension letters by Extension Specialist	1,885
Vineland and Bergen Egg-Laying Contests and allied work	12,500
Reports, bulletins and circulars	99,785
Total	121,117

It would seem to those within the department that the aid rendered by correspondence in solving perplexing poultry problems is one of the most important activities of the department.

ADVISORY SERVICE

In addition to the correspondence, the department is called upon to render much service in the way of advisory trips and inspection visits to poultry farms and poultry flocks throughout the state. This calls for the expenditure of a rather large amount of time on the part of some of the department's staff, as well as a considerable amount of money which is spent in travel, lodging, etc. It would seem, however, that this service must be met in order that the prestige of the department and its reputation and good-will among the poultry fraternity might be maintained. Such advisory trips are usually held at the same time, or in connection with speaking engagements, which are frequent occurrences and which are given at meetings of local poultry associations in cooperation with local groups of poultrymen in the various poultry centers of the state. The advisory service of the department includes an extensive study of poultry diseases, which will be reported upon more fully at another place in this report.

EXTENSION SCHOOLS

During the past two years, there has been a great demand on the part of organized groups of poultrymen throughout the state for some type of organized instruction in their own community. As a result of this demand, during the past year the department has given three organized extension schools. These schools have been held at the Court House, at Paterson, in cooperation with the Passaic County Board of Agriculture; in the Court House at Hackensack, in cooperation with the Bergen County Board of Agriculture and the Poultry Association at Bergen County; and in Hammonton, in cooperation with the Atlantic County Board of Agriculture and the Hammonton Poultry Raisers' Association. These schools have extended over a period of a month, with 8 evening meetings, two each week. A record of attendance has been kept and an effort made to render real service to those pursuing the course. Each evening program has included a lecture or address, in some cases illustrated by a stereopticon. Following this, the meeting has been turned into an informal discussion, and a question box conducted.

It is very apparent from the interest already developing regarding these schools, that the future demand will be great. It has therefore seemed wise to organize the extension school on a more definite basis and to have a memorandum of agreement between the research department and the extension service. With that object in view, the following memorandum has been agreed upon and will be binding upon extension schools held in the future:

MEMORANDUM REGARDING EXTENSION SCHOOLS

The *extension school* is recognized as a valuable means of imparting information to those desiring more intensive work than can be given through the field demonstration or the occasional field meeting or lecture. It is to be considered as supplemental to the demonstration and field meeting, and is in no way displacing them. Extension schools will be considered as a part of the cooperative extension work of the State under the administration of the extension division of the State Agricultural College, the Agricultural Experiment Station, the United States Department of Agriculture and the County Boards of Agriculture cooperating.

Any community desiring an extension school should apply to the county agent, stating approximately the dates and location desired for the school. The county agent should refer the matter to the extension specialist or to the State Superintendent of Farm Demonstration, and learn if instructors will be available for the dates selected and adjust dates if necessary.

Before any school will be held, the following conditions must be met:

1—Not less than 25 persons must register and pay the registration fee, which fee shall not be less than one dollar each.

2—The County Board of Agriculture must give approval to the project and through its executive committee or a special committee designated for the purpose by the President of the County Board, all local arrangements shall be made for the school. These arrangements include rental of hall, heat, light, janitor service, publicity, printing program, etc.

3—A charge of $10.00 will be made for each lecture. Before the school is held, funds sufficient to cover the charge for all lectures must be deposited with the Director of Extension. From the funds thus established, the traveling expenses and maintenance of the lecturers will be paid.

It is recommended that two meetings per week be held at times agreed upon. Instructors will be designated by the Director of Extension and will be drawn from the members of the extension staff, college and experiment station staff or from other available sources. Payment for services of instructors will not be made a charge against the county.

Only those who have paid the registration fee shall be enrolled as members of the school and entitled to follow-up work and demonstrations, but all persons interested shall be permitted to attend any or all meetings and to visit the demonstrations and field meetings.

Each school shall elect a chairman and a secretary, who shall call the roll of members and record attendance of members and visitors at every session. A demonstration committee or field committee shall be appointed, the duty of which shall be to arrange for visits to farms or homes where the principles and practices as advocated in the school are being actually carried out.

Each member registered for the school must report to the county agents the results secured from the practice of the principles taught in the school.

Only a limited number of schools can be held, and these will be booked in the order in which applications are received and certification made by the President or Secretary of the County Board of Agriculture that all required conditions have been fulfilled.

FINANCIAL STATEMENT

The following is a statement of the monthly receipts from cash and credit sales of the department during the year, ending May 31, 1921:

June, 1920	$520.00
July, 1920	1,325.00
August, 1920	1,099.43
September, 1920	1,019.59
October, 1920	982.15
November, 1920	911.89
December, 1920	1,058.61
January, 1921	1,229.48
February, 1921	1,184.40
March, 1921	994.24
April, 1921	505.04
May, 1921	400.00
	$11,230.33

In the above statement of income, no effort has been made to show inventory increase or to analyze the revenue from the net profit. It is merely a statement to show the great volume of poultry products which the department has been able to maintain, and which is greater than the amount of maintenance appropriations granted by the state.

STATE POULTRY FARM

No funds have been available, nor has any effort been made during the past year, to change the buildings or equipment at the State Poultry Farm. An effort has been made to keep the plant in as good condition as possible considering the lack of funds. During the year, the plant was increased to 3,000 hens, which will, of course, be reduced during the summer through culling, etc. The need for painting the buildings, both walls and roofs, and repairing the fences is very urgent, and special funds for this purpose should be granted by the Legislature in order that the plant may be put in perfect condition for another year's work.

EGG-LAYING CONTESTS

The detailed problems of the egg-laying contests will be reported in full in a later part of this report. The Vineland Contest has been continued and enlarged, as outlined in previous reports. The production and general health and progress of the contest has been most gratifying. A second contest was started last fall in Bergen County. A fund of $15,000 was raised by cooperative organizations and individual poultrymen in the county. The state appropriated an additional sum of $25,000 to maintain the contest. This means that New Jersey now has two 2,000-bird, 3-year international egg-laying and breed-testing stations under full operation, producing a great mass of research data. It is planned to start a third contest at some future date in the state, the time and place depending upon the interest of the poultrymen and farmers in the sections available for such a proposition.

NEW POULTRY HUSBANDRY BUILDING

As stated in last year's report, for a number of years there has existed at the Experiment Station and College an urgent need for the erection of a complete and suitable building to house the department of poultry husbandry. The last Legislature appropriated $85,000 for the erection of the building. This building will house the research and instruction activities of the department. Steps are now under way to start its erection. It will be necessary to secure from the next Legislature the sum of $25,000 to equip the new building completely.

POULTRY FIELD MEETINGS

During the past year, two very successful Field Meetings were held by the poultry organizations of New Jersey cooperating with the Agricultural Experiment Station. Poultry Day of Farmers' Week was held at the College Farm on June 19. Over one thousand poultrymen visited the College Farm, attending the morning sessions, and addresses were given by the various members of the Department. Following lunch served on the campus, the visiting poultrymen spent the afternoon inspecting the "Feathered Trail" and becoming familiar with the best known practices of poultry production. During the coming summer, a similar meeting will be held at the University.

One of the most successful field meetings ever held in the state was the annual tour of the New Jersey State Poultry Association, which took place in August, 1920. The tour started from North Bergen County, from which point, in company with the visiting delegation of Connecticut poultrymen, the autos sometimes numbering close to one hundred in line, went through the famous ocean-bound counties of New Jersey, visiting the well-known poultry farms in Ocean and Monmouth counties, thence on to Vineland. Here a day was spent in inspecting the contest grounds and in visiting the important poultry farms in the Vineland district. From here, the tour ran up the western side of the state and visits were made to some of the leading poultry farms in Hunterdon and Mercer counties. The tour proved so attractive to those participating that it will be run again this year.

RESEARCH ACTIVITIES

The research activities of the poultry department have been maintained on a normal basis; no new projects have been adopted. The main efforts have been centered around the breeding and feeding work. The following is a brief statement of the results of the research work, some projects being reported only briefly, since the detailed reports will appear shortly in bulletin form.

Breeding Studies

This project deals with the amount, distribution, and inheritance of fecundity in the domestic fowl, as outlined in last year's report. The opportunity to secure additional data has been doubled by the establishment of the Bergen County Contest, where 2,000 birds are being trap-nested this year.

During the past year, 280 pedigree line-bred, Single-Comb White Leghorn male birds were distributed throughout the state where they would be useful in introducing the Belle of Jersey blood into the commercial poultry flocks.

The cooperative arrangement with Doctor Harris of Cold Spring Harbor is developing very satisfactorily. A number of scientific papers and reports will soon appear covering gametic studies, many of the available facts coming from our contests.

Variation in and Inheritance of Egg Shell Color

About 5 years ago work was undertaken the purpose of which was to study the occurrence of variation in shell color of eggs of the domestic fowl. This project had an interesting promise from the scientific standpoint, in that little satisfactory explanation has been offered as to why the egg shells of our domestic fowls are not always of the same shade or tone. It seems that in those breeds which have been adopted for the commercial side of the industry, greater and greater variation in this regard is found. This persistent fact raised the question as to the possible influence of production and shell color. A short consideration even of the subject pointed out numerous problems for research.

Then, from a more practical standpoint, it was noted that especially in those breeds which characteristically laid brown-shelled eggs there was so much variation in color as to lower the market value of those eggs. It was evident that with greater uniformity of color in such eggs more uniform packs of eggs would be possible. The project then seemed to be justified both as a bit of pure scientific research and as a practical experimental problem, the outcome of which might have a very important message for the breeders of the heavier breeds.

In outlining this work it was at once realized that no small task confronted the department, and that in justice to other important projects also under way only a part of the investigation should be conducted at any one time. Therefore, any work concerning the histology of the shell-secreting portion of the oviduct, or the exact nature of the color in the egg shell, or any strictly scientific phase of the problem, was set aside for later consideration. It was deemed logical and in order to gather together data as to the occurrence of variation in the egg shells of various individual hens; its effect on the marketability of the product, and possibly the behavior of this characteristic in inheritance. Over five years have been given to this more practical phase of the project. Several former reports have referred to the progress of the experiment. As this report is a final statement on this part of the problem a general outline of the nature of the whole work done thus far is hereby given:

A. After saving several hundred eggs from flocks of Barred Plymouth Rocks, White Wyandottes and Rhode Island Reds, these eggs were very carefully examined and compared and each shade and variation of color was chosen. Altogether 28 different shades or patterns of shell color were found. A "stand-

ard" for future reference was constructed by blowing these selected eggs and keeping the empty shells under glass. This method proved to be very practical, convenient and accurate. The colors ranged from a pure chalk white to the rich red usually characteristic of the Asiatic breeds, including all types of spotted shells as well as the even-colored shells.

B. Certain pens of Barred Plymouth Rock, White Plymouth Rock, White Wyandotte and Rhode Island Red pullets were available for the purpose. These were trap-nested from their first eggs through their second years of production. Each egg was marked with the hen number and the date laid. Each egg was then charted as to shade of color (the shell color standard having each shade numbered) in sequence.

C. During one spring season eggs from these birds were pedigree-hatched. Both cockerels and pullets were saved from hens which had shown previous records of certain well-defined egg-shell characteristics, such as uniformity of brown color, intense spottedness, tendency as to light shades of brown and a few that had shown variation in color. These young birds were in-bred back upon the mothers in some cases, and as many matings made as possible to test the behavior of this egg-shell color in inheritance.

Results

It is believed that the results of this project can be summed up quite briefly by making the following statements, thereby not burdening the reader with a mass of data which were accumulated before definite ideas could be expressed.

A. It is an established characteristic of certain breeds of our domestic fowls to produce eggs, the color of the shells of which are more or less uniformly a shade of brown. This shell color has been so well established in some breeds, such as the Asiatics, as to be almost a pronounced mark of those birds. In the breeds of the American class less color has been bred as a characteristic of their eggs and consequently it is usually said that these breeds produced light brown eggs. But within any of these breeds poultrymen have considered the shell color a definite part of the make-up of the birds. This fact, borne out by the holding of brown-shell color through many generations, would seem to point to the fact that such was indeed an inherited character, and not a condition influenced by environmental conditions, feeds or other agencies. That this is apparently true was further indicated by a study of the egg-shell color of pullets whose mothers' characteristic shell color was known. Daughters of hens that habitually laid eggs of a deep uniform brown, for example, tended very markedly to follow in their footsteps. Daughters of hens that had varied from white to spotted and to dark brown showed a similar tendency to lay eggs that if taken all together would have resembled Jacob's coat of many colors. An attempt was made by directing the matings in certain ways to determine whether or not this character was sex-linked in its mode of inheritance or not. While a rather small number of matings was available for this exact work the indications were to the effect that both male and female lines were important in the building up of this character within a strain or family of fowls.

B. From the facts mentioned above it seems safe to say that breeders of these types of fowls can so select and mate their birds as to improve the color of the eggs produced. It certainly would be a great advantage to be able to breed a strain of birds that among other things would produce eggs of uniform and desirable brown color. It would increase the selling value of the brown eggs immeasurably. This characteristic should be borne in mind when the males and females for the mating pens are selected.

C. The trap-nest, used possibly for only the winter months (better for longer periods), will enable any poultryman to learn the identity of the hens in his flocks that are producing the kind of eggs he wishes to produce with a greater degree of regularity. It means more work, but it also means increased returns later. A few well-selected hens will establish a good beginning. The poultryman should bear this in mind along with the other qualities that are watched for when selecting the breeding fowls.

D. A good step in advance along this line can be made by selecting the eggs which go into the incubators. Only those should be selected which are of the color considered ideal or nearly ideal for one's birds. Of course, it is true that many of them will be from hens that vary in egg-shell color, but the odds are very appreciably in favor of the practice.

It is hoped that at some future time the biological features of this work may be undertaken by the department, and possibly more exhaustive work of the same practical nature as discussed above may be carried out. The main object of beginning this investigation was to have some reliable data as to the actual occurrence of variation in egg-shell color among common fowls and to outline a simple, practical method for the general improvement of egg-shell color. This object was realized, and it opened up a field of work of intense interest. We are continually seeking ways in which to better our birds. Let us use every means that is worthy, economical and available.

Egg-Laying and Breed-Testing Stations

The objects of this project were discussed at length in the Annual Report for 1920, together with many interesting results obtained during the first contest at Vineland and the first year of the second contest at the same station. This year finds us in the midst of operations at two contests, one at Vineland, and the other at Westwood.

The organization at the Vineland Contest is definitely established and the experiences of the past 4 years have made for efficiency in all directions. The station staff consists of a foreman, who is directly responsible for all work going on and for the safeguard of all property. The assistant foreman has charge in the absence of the foreman and is directly responsible for the health of the birds. In addition to these are two poultrymen, assistants to the foreman, who attend to all routine work such as trapping and cleaning. This year being the breeding year, two experts were engaged to handle the incubation and brooding.

The process of pedigreeing baby chicks and following up their records throughout the growing season is a stupendous task and is accomplished in the following manner. All eggs from the contest are trapped and bear the number of the individual producing them. They are incubated and handled as usual until the eighteenth or nineteenth day, at which time it is necessary to sort them according to hens and place them in cheese-cloth bags, together with a check tag bearing their numbers. Each bag is then tied or pinned tightly and returned to the incubator. When the chicks are hatched they must be released from their confinement as soon as possible, and at that time a band is placed around the leg of each, its number being recorded against the pen and individual producing the egg.

The brooding takes place on a range of 6 acres covered with an abundant growth of alfalfa and clover, which affords excellent shade. Twenty houses are in use and each is heated by means of a coal brooder stove. At frequent intervals the bands must be loosened to allow for proper growth, especially in the case of the heavy breeds, and at about the fourth week they are removed and placed in the wing as a permanent record. Mortality has been exceptionally low and the chicks are in perfect condition—over 8,000 of them.

The cockerels are separated from their sisters and are placed on a different range where they live until sold to pen owners for breeding purposes or shipped to market for meat. The pullets remain until they have reached such a growth that a good selection may be made. The best twenty from each pen will take the place of their mothers to carry on the third year of the contest, the remainder to be disposed of in the same manner as the cockerels.

A remarkable feature of the present year of the Vineland Contest is the high production, mounting from 20 per cent in January to 40 per cent the first of February, to over 50 per cent the first of March, and to its high point 68.61 per cent (average for a week) the first of April, hovering near that mark for two months and at the present writing still considerably over 60 per cent. *These are hens in their second laying year.*

The high pen at the present time is No. 46, Single-comb White Leghorns, from C. T. Darby, North Branch, with 1,329 eggs in 32 weeks. The record was held for some time by pen 5, Barred Rocks from Glenlyn Farms, Downington, Pa.

The organization of the Bergen County Contest has reached a fair stage of efficiency but not without many difficulties. The contest was begun November 1, 1920, with the plant still under construction and little cooperation from the body from which much had been expected. Construction is practically complete now with the exception of a few minor details, and the plant makes an attractive appearance for those who motor through that country on the Kinderkermack highway.

In planning the laying houses care was taken to minimize the labor as much as possible, and the houses were laid out in two double rows diagonally opposite each other. In this way no steps must be retraced and the time taken to cover the ground in the routine work of feeding, trapping, and cleaning 100 houses is greatly lessened. The staff is identical with that of the Vineland Contest with the exception of 2 brooder men. The superintendent of contests, who formerly was in direct charge of the Vineland station, now has headquarters at New Brunswick, where he can keep in close touch with both contests, and also with the mass of detailed records involved. These records require the full time of one woman clerk and part time of several others, as they must be accurate and absolutely to date.

The egg production at Westwood has not been as high as might be expected, partly due to the fact that some of the pullets arrived in laying condition and were broken up; partly because of the unfinished condition of the plant; and our inability to get the birds out on the range early, but mostly on account of the ravages of the dreaded disease roup, which has given much trouble during the past season. It is impossible to explain its prevalence there, but it may be said that we have gained control and the egg production is holding out at a constant rate at the present time.

Great results are anticipated for next year and ensuing years at the Bergen County Contest. The location and climate are ideal and the people are interested.

Financially the contests are on their feet. The income from sales of market eggs, hatching eggs, and stock produced being sufficient to carry such expenses as labor, feed, and incidentals, while the $5,000 appropriated by the state for each contest covers the salaries of the superintendent and foreman and such expenditures as the building of extra houses, etc.

On the whole, these contests in New Jersey have measured up to all expectations, have produced results, are widely popular, and are taking the lead in revolutionizing and enlarging the poultry industry of the state.

Poultry Exhibitions

The administration of the special fund appropriated by the Legislature to make possible a greater development of the poultry business in New Jersey has progressed very successfully.

During the past year the following associations have benefited by this act to the following amounts:

Atlantic County Agricultural Fair, Sept. 9, 10, 11, 1920	$300.00
North Bergen County Poultry Association, Nov. 25, 26, 27, 1920	300.00
Gloucester County Poultry Association, Dec. 16, 17, 18, 1920	300.00
Paterson Poultry and Pet Stock Association, Nov. 16-20, 1920	300.00
Phillipsburg Poultry, Pigeon and Pet Stock Association, Nov. 22-27, 1920	300.00
State Show, New Jersey State Poultry Association, Nov. 29-Dec. 4, 1920	750.00
Trenton Interstate Fair, Sept. 27-30, 1920	450.00
Vineland Poultry Association, Dec. 8-11, 1920	300.00

In the past, on account of the newness of the act and until detailed problems of administration presented themselves, it has been the policy of the poultry department to allow the greatest of latitude to the local poultry associations. Hence during the past year the following questions have been left to each local association:

How the money should be awarded, whether special premiums or regular premiums, on what class it should be placed, and in what amounts.

In every case but one this has worked out to the entire satisfaction to everyone concerned and harmony has prevailed.

The following suggestions are made for next year:

The Agricultural Experiment Station has placed in their budget an item of $7,000 to apply on this act, this amount being sufficient for each local association to have its full allotment of $400 for premium money, and $1,000 being set aside for overhead administration. Out of this, the Trenton Fair will be entitled to their full allotment of $600 and the State Show its full share of $1,000. After the experiences of this year it has been decided to leave the question of an educational program to the association concerned. If they wish to put on an educational program of lectures and demonstrations, a sufficient amount to cover the demands of such a program will be drawn from the premium money available. If they decide not to run an educational program, and there is no doubt but that some will decide to omit this, the full amount will be put in the premium money.

If we put this plan through this winter, we shall need the unanimous support and active work of those participating in New Jersey.

The Amount and Causes of Embryo Mortality

During the past year, because of the absence of Mr. Hannas, the research work on the amount and causes of embryo mortality was temporarily set aside. Undoubtedly one of the weakest points in poultry culture today is the propagation of the flocks; there are still many secrets which the mother hen has not divulged to her master. The management and operation of the artificial incubator is fairly well understood, and yet the results obtained in these machines do not reach sufficiently near perfection to warrant our being satisfied. During the coming year work on this project will be resumed with the particular idea in view of studying the mechanics of the incubator and their effect upon the development of the embryo. As the work progresses undoubtedly there will be many points of interest brought to light that will bear further investigation.

Influence of Ration Upon Egg Production

Much has been said in recent years about the proportion of whole grain to dry mash fed to laying flocks. Very probably there is a relationship between the amounts of these two types of poultry feeds which if carried out will result in a more efficient and economical egg production. This proportion may vary at different seasons of the year and with the condition of the birds. In order to obtain some reliable and accurate data on this problem a rather elaborate feeding experiment was begun during the past year; 19 pens, each containing 50 Single-Comb White Leghorn fowls, were made available for this work. These flocks were divided into groups containing 4 pens each, with the exception of the last group which only contained 3 pens. Following is the general plan of the experiment in brief:

Group 1. Pens 25 to 29, inclusive, received a ration consisting approximately of 3 parts of whole grain, scratch grain, to 1 part of dry mash by weight. Pen 25 received a basal mash, which consisted of the regulation New Jersey dry mash minus meat scrap. Pen 26 received a mash containing 10 per cent meat scrap. Pen 27 received a mash containing 20 per cent, and pen 28 received 30 per cent of meat scrap. In each of the other groups, the 4 pens received respectively the same types of mashes.

Group 2. Pens 29 to 32, inclusive, received 2 parts of whole grain to 1 part of mash.

Group 3. Pens 33 to 36, inclusive, received equal parts of whole grain and mash.

Group 4. Pens 37 to 40, inclusive, received 1 part of whole grain and 2 parts of mash.

Group 5. Pens 41 to 43, inclusive, received 1 part of whole grain to 3 parts of mash.

In this last group, there was no pen given a bare mash. This was due entirely to the limitations of the poultry house in which the experiment was conducted.

This general plan of feeding was carried out as carefully as possible during the 11 months; this period has just closed at the time of writing this report, therefore only a tentative report can be made as to the results of the experiment. It is hoped that the assimilation and analysis of the data will we sufficient to warrant the publication of a circular or bulletin later in the year. Suffice it to say for the present that in glancing over the tabulation of the data thus far completed, the following general conclusions seem evident:

First, the dry-mash portion of the ration fed to laying fowls is undoubtedly the source of the greater part of the protein elements in the feed, which elements are primarily essential for the production of eggs. In other words, it is to the dry mash that we should look for the materials from which eggs are to be produced economically; the whole grain fed usually in the straw or litter is used largely by the birds for the purposes of body maintenance and warmth.

Second, during the period of the year in which egg production reaches its highest point, the amount of mash used by birds far exceeds the amount of whole grain. This undoubtedly is the case when birds are given their choice. A glance at the pens receiving the various proportions of mash and grain mentioned above would seem to indicate this same thing.

Third, it is difficult, if not impossible, to plan a system of feeding in which the proportion of grain to mash is uniform, or even approximately so throughout the year, since this proportion is affected by the condition of the fowls at the different seasons of the year. Pullets just beginning production need more grain than mash; fowls in the height of production need more mash than grain.

Fourth, that meat scrap is a vital part of the laying mash is proven by the low production of the basal mash pens. In general, the pens receiving 20 per cent of meat scrap produced the greater number of eggs. The pens receiving the 30 per cent of meat scrap ration did not excel this other group, and consequently it is assumed that in this experiment particularly, there were few if any eggs resulting from the extra 10 per cent of meat scrap.

Sixth, this very hasty review of the experiment simply points out a few generalities. A complete study will surely reveal some interesting concrete facts. It is hoped that by a more careful investigation of experiments of this kind we may be the better enabled to formulate a program of feeding which will help us more economically and more efficiently to produce more eggs.

Influence of Artificial Illumination Upon Egg Production

The progress of this experiment has shown beyond question the wonderful results which may be expected and derived from the use of lights by the evening lunch method, which was discussed fully in the last annual report. During the past year, 1,100 birds at the station plant at New Brunswick, have been run on this method, resulting in a production far above the average run of the plant. During the year, additional data were required on the exact influence of illumination on the evening lunch method as compared with non-illumination, with the result that an experiment was run on two pens of 42 birds each. By studying these results, one can readily see that the lighted pen showed a considerably greater production during the late fall and winter months. It was only in late February and March that the production from the unlighted birds began to approach that of the lighted birds. Comparing the production with the price of eggs, we see that eggs are highest during the early fall and winter, which is just the time when the lighted birds showed the greatest increase in production over the unlighted birds. In the spring, when the prices are low, the production from both pens was more nearly equal.

From this we are able to draw the conclusion that not only do lights enable the poultryman to secure a greater yearly production from his birds, but they make it possible to secure the eggs when the prices are high.

Poultry Flock and Farm Management Studies

During the year no extensive work has been undertaken under the project which deals with poultry farm management studies. Co-operation has been given the State Department of Agriculture in their efforts to secure correct information on the state poultry farms in New Jersey. The poultry flocks at the State Farm have been maintained and the records obtained are available for study. It is thought that in the future it will be possible to publish a bulletin covering the farm management studies representing the past 5 years' period at the College Farm.

Control Work With Contagious Epitheliosis

During the past year intense interest has been manifested in practically every poultry-raising section of the state in the possibility of controlling the losses annually caused by chicken-pox, roup, and canker. In January, 1921, representatives of various poultry farms met with members of the department staff and invited guests, the latter being scientific men of national reputation who were interested in some phase of this work. A thorough discussion of the whole problem that lies before us in New Jersey was taken up, and certain proof was submitted of the enormous losses that were being annually caused by these serious epidemics. It seemed to the department that in order to conduct a campaign against this enemy the work done elsewhere should be well understood. Consequently, the following report was prepared, and is hereby presented, with the idea that it might contain many points of interest to poultrymen throughout the state:

In examining the reports of scientific workers, as well as those of poultrymen whose flocks have been infected with the diseases, it seems that there has been little clear understanding in the minds of these interested parties of just what types of disease were meant when the various names were used. This has led to some confusion and has made somewhat difficult the task of gathering together full information on just what has been done toward the solution of this problem. Therefore, in presenting this report a definition of terms is necessary, and all reports referred to have been reduced to these terms, for the clearer understanding of the work done.

1. *Contagious Eye Roup* has been widely known in New Jersey and rather commonly recognized as that form of disease which produced the following symptoms:

Early symptoms appearing in nasal passages; similar to the symptoms of acute nasal catarrh, but having a characteristic bad odor, and producing more dullness in the bird; at first discharge thin, serous, later becoming thicker and glutinous, causing affected birds to sneeze and shake heads.

Infraorbital fossae become inflamed and distended with pus, forming an enlargement on one or both sides of head below eyes.

Eyes—first a thin serous secretion is observed flowing from corners of eyes; later becoming turbid, thicker, adhering to edges of lids, drying; accumulates as rather hard yellowish mass, causing pronounced bulging of eyes; sometimes infection develops posteriorly to eyes as abscesses which force eyes foward; corners often turbid and ulcerated; destruction of eye often results.

Continued roup condition:
Lowers vitality;
Stops egg production.

2. *Canker* is usually taken to mean that form of the disease which affects the mucous membrane lining of the mouth and throat, and is identified by the following characteristics: Begins by slight redness or inflammation of areas; in day or so followed by appearance of yellowish or whitish spot, which rapidly enlarges and spreads; accumulations of yellowish rather hard deposit; may be
Anywhere on surface of mouth;
At junction of mandibles, "jaw canker;"
Entrance to trachae "throat canker"

Results in:
Lowered vitality;
Lowered productive ability;
Suffocation.

In throat form may spread down aesophagus, or into bronci and lungs.

3. *Chicken pox* is that form described when lesions are found on the skin and featherless parts of head. First noticed as fine gray vesicle, which soon

develops into small elevations of reddish gray color, later grayish yellow, and sometimes black (because of dirt adhering), are masses of degenerated epithelial cells. Later become enlarged, hard, dry and easily removed, showing raw granulating areas beneath.

Workers at Nevada, California, Ohio, Kansas, as well as here at the New Jersey Station, all recognize these forms of disease, and all seem to agree that there are indications in most flocks that there is more or less definite relationship between these forms. It probably remains a matter for research to determine the final answer to this extremely important question.

Work Done

Several rather definite attempts have been made to isolate the organisms which were responsible for any or all of these forms of disease. The Ohio, Nevada, California, Kansas and Missouri stations have conducted certain experiments with this end in view. To summarize briefly the results from the Ohio work:

A bacteriological study of epitheliosis of birds was made under the direction of the writers by Dr. Israel Wallman.

The experiments consisted in the following:

1. Collecting cultures from the different lesions in each case, and isolating the organisms which were cultivated in pure cultures to study their cultural characteristics and pathogenicity.
2. Experiments with the blood to determine its virulency.
3. Experiments with the filtrate from an emulsion of scrapings from mucous membranes and cutaneous lesions.
4. A study of the pathogenicity of each of the different organisms alone, combined, and in connection with the filtrate.
5. Experiments in transmitting the disease by direct inoculations from the lesions.

Seventy-four cases of various forms of the disease were used in these experiments. Of these 54 showed lesions on the mucous membrane only, 8 cutaneous lesions, and 12 had both forms. Normal birds were used as controls.

In carrying out this line of work Dr. Wallman found certain organisms:

Organism No. 1. (Probably the bacillus *diphtheriae columbarum* of Loeffler).

A short, thick, highly motile bacillus taking a bipolar stain, gram negative.

Broth: Slight deposit and scum.

Dextrose-broth: Acid, no gas production.

Sucrose: Same.

Lactrose: No acid, no gas production.

Milk digested without acid production, gelatin and blood serum digested.

Does not produce indol nor reduce nitrates.

On agar abundant growth, edge leaf-life.

Agglutination:

Normal blood serum agglutinates it in dilutions of 1 to 5.

Serum from sick birds agglutinates it completely in dilutions of 1 to 20 and partially in dilutions of 1 to 60.

Complement fixation test:

Using an extract of this organism as an antigen did not produce fixation of the complement.

Antigen was prepared as follows: Ortanism was grown on agar and emulsion made in 0.85 per cent NcCl solution heated for 1 hour at 60° C. and shaken for 36 hours at 480 strokes per minute. A 1 to 20 dilution of the extract of the organism did not prevent hemolysis. A 1 to 40 dilution of the antigen and positive serum in amounts varying from 0.03 cc. to 0.5 cc. was used for the test.

Pathogenicity: Healthy young chickens were inoculated as follows:

1. Two inoculated subcutaneously on the comb.
2. Two inoculated submucously in the oral cavity.
3. Two inoculated intravenously.
4. Two inoculated intraperitoneally.
5. Two inoculated by scarifying the wattles.

In birds No. 2 and 5, local lesions appeared on the second day, lasting an average of 5 days, and resulting in complete recovery without producing the typical diseases, *i. e.*, there were no general symptoms.

Organism No. 2. A small motile bacillus resembling a diplococcus.
Stains, by all ordinary stains, gram negative.
Broth: Grows in small chains.
Agar: Moist, transparent grayish growth.
Blood serum: Not digested.
Gelatin: Liquified slightly.
Potatoes: Grayish growth.
Milk: Coagulates with acid production.
Sucrose-broth: Acid and gas production
Dextrose-broth: Acid and no gas.
Lactose: Acid (slight) and no gas.
Negative results on agglutination and complement fixation test.
Pathogenicity: A test made as with organism No. 1, resulting in a light swelling at the point of injecton in mucous membrane and skin lasting for a few days without producing the disease.

Organism No. 3. A small non-motile cocco-bacillus.
Gram positive.
Gelatin and blood serum: Not digested.
No action on normal or litmus *milk.*
Dextrose and sucrose broth: Acid and no gas.
Lactose: No change.
Does not produce agglutination or complement fixation.
Pathogenicity: Does not produce the disease.

Organism No. 4. A large motile square-ended bacillus resembling *B. agiles.*
Gram negative.
Broth: Membranous scum.
Gelatin: Arborescent growth and digestion.
Agar: Abundant, spreading moist growth.
Milk: Coagulated and digested with slight acid production.
Blood serum: Not digested.
Sugar-broth: No change.
Pathogenicity: Produces lesions but no general symptoms.

Organism No. 5. Pseudomonas pyocyanea.
Pathogenicity: Swelling and inflammation at point of injection. Intravenous injection resulted in septicemia recovering the organism from heart, kidneys, etc.

Organism No. 6. A small slender, highly motile bacillus.
Gram negative.
Produces a brick-red growth on *agar, potato, gelatin and blood serum.*
No coagulation in acid in *milk.*
No change in *sugar broth.*
Not pathogenic.

Organism No. 7. A small non-motile cocco-bacillus.
Gram negative.
Gelatin and blood serum: Not digested.
Milk: No acid or coagulation.
Sugar-broth: No change.
Does not form indol nor reduce nitrates.
No special characteristics as to cultural growth and pathogenicity.

Organism No. 8. ***B. necropherous.***

Organism No. 9. A colon-like organism.

Gram negative.

Gelatin and blood serum: Not digested.

Milk: coagulated.

Acid in litmus *milk.*

Lactose broth: Acid and gas.

Sucrose-broth: Acid and gas.

Dextrose broth: Acid and no gas.

Organism No. 10. *Staphylococcus albus.*

Organism No. 11. *Staphylococcus aureus.*

Organism No. 12. *Micrococcus citreus.*

Organism No. 13. *Sarcina tetragina.*

From the description of the pathogenicity of the different organisms it is seen that none were capable of producing the typical disease symptoms. On injecting an emulsion of all the different organisms more extensive lesions were produced.

The examination of the blood of sick birds resulted in finding no organisms, and the inoculation of healthy birds with varying amounts of blood serum from the affected birds, produced no disease.

The following sums up the results of the third experiment:

Four birds with all the clinical symptoms of the disease were killed and an emulsion of the heads of the birds passed through a Berkefeld filter. Each head was macerated and triturated separately with sterile sand and sterile physiological salt solution. The emulsion of each head was separately filtered through a Berkefeld filter. The filtrates were tested out on culture media and no growth was present. Six birds were inoculated with each filtrate, two of them subcutaneously, two submucously, and two intraperitoneally. Four birds were used for the four different filtrates. Daily records were taken as to the temperatures, appetite and other clinical symptoms. The birds remained normal until the twelfth day and from the twelfth to the twentieth day all of them became sick. All showed an elevation of temperature of 2 degrees or more, dullness, and loss of appetite. Eleven had nasal discharge, eye lesions and saliva of a thick consistency. Seven had yellow caseous deposits in the mouth. Of these, 3 died in a few days and inoculations on media from the heart and liver showed no growth. Six birds showed general symptoms of roup but no local lesions.

The results of the fifth experiment follow. Its purpose was to transmit the disease by inoculating the mouth deposits of sick birds into healthy ones:

Six birds were inoculated submucously with scrapings from those lesions and on the third day pustules appeared at the point of injection. On the fifth day a yellowish membrane appeared. Lesions disappeared on the tenth day and typical symptoms of the disease were not produced.

In further continuing their work at Ohio, Dr. Brumley and Dr. Snook experimented with a vaccine against these diseases. Their summary of conclusions follows:

1. From the bacteriological experiments we have made and the good results obtained from vaccination, we are of the opinion that we have been dealing with one disease only. Owing to the confusion in names which have been used to designate this disease, we have concluded to give it a new name—Infectious epitheliosis of birds (*Epitheliosis infectiosa avium*). This indicates involvement of the epithelium both of the skin and mucous membranes. It was thought that inasmuch as we find so many variable forms of the disease, this name would be more appropriate than any combination of names so far suggested.

2. Our work extending over a period of 6 years convinces us that typical infectious epitheliosis is due to a combination of two factors: (a) A filterable virus; (b) Secondary invading organisms which vary in kind but of which the so-called *Bacillus diphtheriae columbarum* of Loeffler, appears to be the most important.
3. The filterable virus is the necessary primary invader which lowers the bird's resistance and thus prepares the tissues for the invasion by the secondary organisms. Neither factor alone will cause the typical disease.
4. The excellent results derived from the use of a vaccine made from the secondary organisms, both in prevention and treatment, are due to controlling the secondary infections which cause the serious complications. If these are controlled infection due to the primary virus is mild and soon disappears. (There is a remote possibility that the filterable virus is contained in the vaccine. We have no evidence that this is or is not the case. The presence of the virus in the vaccine would indicate its growth with the other organisms on the cultures. This would be contrary to our present knowledge of filterable viruses. This point will be investigated.)
5. The therapeutic dose, as indicated by the large number of birds treated, is 1 cc. for the average adult bird. Younger and smaller birds receive a lesser amount.
6. The immunizing dose found most satisfactory is 1 cc.
7. No bad results have followed when larger doses have been administered.
8. Reports received to date indicate that vaccination is equally efficacious in the treatment of infectious epitheliosis in turkeys.

At the Nevada Station in 1915, Dr. Mack and Dr. Records observed outbreaks of these diseases, from the description of which it would seem were similar to those observed in Ohio. All forms of the disease were noted in the various flocks worked with. The results of their work are summed up in the following conclusions:

The etiological identity of roup, *avian diphtheria*, and contagious epithelioma is a subject of controversy which requires further extended research to settle. For that reason it is uncertain whether the cases dealt with in these experiments were caused by pure contagious epithelioma virus or were due to mixed infection.

The use of a virus prepareed by triturating the morbid products collected from the skin and mucous surfaces and attenuated at 55° C. for 1 hour checked the spread of the disease promptly and exercised a favorable influence upon visibly infected birds. Cases thus treated ran a shorter and milder course than those not treated, and the mortality was materially reduced.

Two injections were sufficient in most instances, but severe advanced cases benefited by a third and larger dose.

In five flocks containing 3,062 birds, 1,668 of them thoroughly exposed. and 1,394, or 45.52 per cent, of them visibly infected, the spread of the disease after vaccination was negligible. Of the 1,394 visibly infected birds treated, 299, or 21.45 per cent, died, and 1,095, or 78.55 per cent, recovered.

On the whole, the treatment was satisfactory and successful. In 5 flocks no unfavorable results followed the subcutaneous administration of the vaccine, but in two flocks serious toxic and septic processes were apparently caused by it. The crude preparation used is not, therefore, without danger, and a more refined product must be devised. However, the conclusion that in this method we have a fairly efficient means for promptly checking outbreaks of contagious epithelioma, or the other uncertainly defined diseases,

> if there be more than one capable of producing similar morbid conditions in fowls, and a therapeutic agent of considerable value, appears warranted. Futhermore, that the prevention and control of this disease, or group of diseases, may eventually be placed on a sound scientific basis seems certain.

The California Experiment Station for several years has been working in a very definite way toward the prevention of the group of diseases which has caused serious losses in the large poultry centers of California. Dr. J. R. Beach has been a leader in this work. Dr. Beach has the following to say with regard to the relationship of the diseases:

> We have very good evidence that chicken pox and canker of the mouth and eyes, as it occurs in California at least, are due to the same cause, namely, the "filterable virus of chicken pox." By the term "canker" I mean lesions characterized by the formation of masses of adherent cheese-like exudate on the mucous membranes of the mouth or eyes. I do not mean to say, however, that all cases of canker are due to chicken pox or are caused by injury to the mucous membranes of the mouth and eyes by foreign bodies, such as barley awns, etc. This occurs most frequently in the eyes and cleft. We also find quite frequently canker of the mouth which we classify as malignant canker. The reason for this classification is that it does not respond to treatment. There is this difference of canker due to chicken pox and the other two forms mentioned. Canker due to chicken pox is liable to affect a large number of birds in a flock at the same time while the other two forms seldom, if ever, affect more than a few birds in a flock at the same time. In addition, if the canker is due to chicken pox we can practically always find some birds in the flock with external lesions of chicken pox. Furthermore, since we have observed such a large number of cases, we are usually able to determine from the appearance whether canker is due to chicken pox or some other cause. The difference in appearance is so slight, however, that it would be difficult if not impossible for me to describe the difference. In all outbreaks of chicken pox in which we have had an opportunity to take accurate data, we have found a larger percentage of the diseased birds with the canker lesions only than with chicken pox lesions only.
>
> In our experimental work we believe we have determined that vaccine prepared from chicken pox scabs only will protect against canker as well as chicken pox. It may be that the disease as it appears in California is different from the disease as it appears in the East. Our idea of the roup also appears to be somewhat different from yours. We describe roup as a disease characterized by a nasal discharge. This discharge is at first clear and watery but later becomes turbid and viscid and may contain yellow flakes. This discharge has a tendency to collect in the nasal sinues where it undergoes rapid transformation into a cheesy mass. The inflammation may extend to the mucous membranes of the mouth and eyes and in that case causes the formation of masses of cheesy material in the mouth and eyes. This, however, does not commonly occur. The first stage of the disease is termed as common "colds" and the second stage when there is a swelling of the jaw due to the collection of the cheesy material in the sinuses we call roup. It is our belief that if all birds were given proper treatment there would be no roup. We do not consider colds and roup as due to any specific organism.

In a later letter Dr. Beach supplements the foregoing by saying:

> We consider the majority of such lesions to be due to chicken pox virus. In many natural outbreaks we find the eye and mouth lesions to be predominant. The vaccine prepared from desiccated scabs has proven effective in controlling canker of the mouth or eyes. We do not find it practical to vaccinate pullet flocks in the late summer or fall with chicken pox vaccine. We have found that the length of time that the protection afforded by the chicken pox vaccine will last to be variable. We have known individual birds to be protected for two years, and on the other hand we have known the protection to run out in three or four months. Therefore, vaccination of pullets in the fall is no positive assurance that they will be protected against chicken pox during the following summer. For this reason we do not recommend that chicken pox vaccine be used until the disease is actually present in the flock. It has been our experience that if fowls are vaccinated as soon as the first cases appear the disease is promptly checked. This seems to us to be the most effective way of using chicken pox vaccine. There are occasionally flocks in which the disease continues to spread for some time after vaccination. In such flocks a second treatment is advised. A second treatment is always advised for flocks in which the disease has made considerable headway.

The California Station, under Dr. Beach, has apparently done more extensive work in the use of a vaccine against these diseases than any other station. As a part of their veterinary research work, with large equipment and personnel at their command, they have been able to conduct experiments which are exceedingly interesting and valuable. The preparation of a vaccine for the prevention of chicken pox of fowls and the allied affection, avian diphtheria, or canker of the mouth and eyes, has been developed and has given sufficiently good results to warrant its being adopted by many practical poultrymen in California.

Commenting on the work at California Dr. Beach says by letter:

> During the year ending June 30, 1920, we distribuetd over 300,000 doses, charging a cent and a half per cubic centimeter. This amount was found sufficient to cover the cost of preparation, leaving a small surplus that has been used for poultry disease investigation. This work has been carried on as an activity of the experiment station, but would probably be discontinued if the manufacture of vaccine was taken up by commercial laboratories so that poultrymen could get it from them as easily as from us. We have done this purely because we thought it a service to the poultry industry of the state. At first we confined the distribution of the vaccine to poultrymen of California only, but, however, requests for vaccine and virus from other stations have become so numerous that we applied for and were granted a federal license to distribute the vaccine or virus anywhere in the United States. We do not feel at all certain that virus produced in this state would prove as efficient in the eastern states as it does here. We do not know that there is not considerable difference between the strains of virus which exist in the East and here.

From Missouri

An interesting communication from Prof. A. J. Durant, of the Veterinary School at the University of Missouri, has been received at the department, and hearing directly on the subject, is quoted in part. Referring to the work of Dr. Beach at California in the beginning Professor Durant says:

They grow the virus for the vaccine by inoculating roosters on the comb. This form of vaccination in my mind is undoubtedly an efficacious means of combatting the disease not only as a preventive but as a cure. It is well to remember, however, that this form of roup is probably the most mild and less fatal than the other forms.

For the past three years I have been experimenting with vaccines for roup and it has been my experience that vaccine made from lesions produced by contagious epithelioma has proven the most efficacious in prevention and cure of this disease.

I herewith mention one case which illustrates this. In a flock of 54 chickens, 40 birds showed lesions of this disease. Two of them were brought to me for treatment. Scabs were formed over the head and around the eyes and both eyes were closed from these scales and scabs. The scales and sores were removed very carefully from the heads of these two birds and made into a vaccine and the two birds were vaccinated with the prepared vaccine. The rest of the flock were vaccinated with the same material. The two birds treated and under observation in the laboratory showed almost immediate improvement and in 5 days appeared again normal. The only evidence of the disease that was left was scars on the head from the lesions. The two birds were vaccinated again in 5 days and completely recovered. All of the flock recovered except one bird which apparently was affected with some other disease. The 14 birds that showed no evidence of the disease at the time they were vaccinated never developed symptoms. This is an illustration of some of the good results that I had with vaccine for roup. One batch of vaccine which I made up from a large rooster which was infected in the lungs with roup and from which I made the vaccine proved to be excellent in preventing and curing cases of similar nature. There have been times in the 3 years that I have experimented with vaccine that there were apparently no results from vaccination, while at others I have had remarkable success.

Vaccine is prepared as follows: In the first place we must recognize three different forms of roup; the chicken pox form, or epithelioma of the comb and bare parts of the head; the diphtheritic form of roup affecting the nasal and oral parts which sometimes extends down into the lungs and causes solidification of those organs; and the eye form which causes swelling and often destruction of the eye from pressure. These are the three common forms of the disease and are the ones from which I got material to prepare vaccine. The disease exudates can be removed from around the eye. The scales and sores from the comb and bare parts of the head and the diphtheritic membranes which occur in the mouth and throat are used for preparing this vaccine. These materials are put into a mortar and are thoroughly ground up with just enough salt solution to make it of a soft consistency. This grinding should be carried out very thoroughly; then a physiological salt solution is added and the material is filtered through four layers of sterile gauze. The filtered solution is then diluted and a fairly cloudy solution one which is much more cloudy than a commercial vaccine, is obtained. This should be shaken in a bottle for 5 or 10 minutes, then heated for 1 hour at 55° C. Then add to this solution 10 per cent of a glycero-carbol-salt solution. This solution is made up as follows:

85 cc. of physiological salt solution,
10 cc. of glycerin,
5 cc. of carbolic acid.

By 10 per cent of this I mean find out what 10 per cent of the total volume of your vaccine is and then add that much of this glycero-carbol-salt solution. This vaccine then is administered in a 1-cc. dose at intervals of 5 days until two treatments are given in case of healthy chickens, and in case of diseased birds the treatment is repeated until recovery occurs. The vaccine is injected in the bare spot on the butt of the wing. About an 18-gauge needle is used to inject the solution and it is not necessary to use any disinfectant, but care should be taken that everything is clean that is used for the injection. In injecting the solution the needle should be passed through the skin and then shoved along under the surface of the skin for some distance before expelling the vaccine. This method will prevent the vaccine from running out of the hole left by the needle which would happen if it were expelled just under the skin at the point the needle passes through the skin.

The difficulty that we have with this vaccination for poultry is that we do not have the vaccine standardized and have learned only by experience just how to make up the preparation and also we are handicapped in that we cannot produce a large amount of the vaccine but are limited to the amount that we can secure from diseased birds. Previous experiments have shown that only the epithelioma form of roup can be transmitted successfully artificially and for that reason we have not been able to produce vaccine in large amount and furnish it to poultry raisers over the state. I should think that it would depend a good deal on the form of roup that you are troubled with as to the probability of applying this vaccination for its control when you have received the information from Dr. Haring of Berkely which will explain to you exactly the possibilities along that line.

As to the other forms of roup I am frank to say I do not know what to advise and am simply giving you my experience with vaccination. In writing to hundreds of poultry raisers in the state of Missouri in regard to control of this disease, since we cannot furnish them with vaccine, I advise the following procedure in handling roup.

The affected birds should be immediately isolated, and where new cases are appearing in a flock daily I advise the dipping of the heads of healthy fowls in a solution of 2 parts of cottonseed oil to 1 part of kerosene, as a preventive measure in the spread of roup. The worst cases of roup should be destroyed and deeply buried or burned, since it does not pay to treat the worst cases of this disease. Mild cases should be shut up in a well ventilated, dry coop and fed only soft mashes in limited quantities. They should be given about thirty drops of turpentine, followed by a teaspoonful of salts, and the beginning of the lesions on the head should be painted over thoroughly with iodine. Birds if taken in the early stages and treated promptly in this manner will usually show an early recovery. In my five or six years' experience and study of this disease I have found that very often with birds that show a bad infection with roup, the disease was very probably induced by heavy infection of parasites, especially worms. As a rule birds that are kept in right condition and properly housed, and fed properly balanced rations are much more resistant to this disease. I have been able in some cases to control outbreaks of this disease in flocks by the application of a thorough treatment for internal parasites, these being the predisposing factors.

> Roup in this state has not been as bad this fall as last fall, due, I think, to the warm weather that we have had up to date. Last fall was the worst year for this disease in Missouri that I have ever seen and there is no doubt but that climatic conditions influence this trouble to a great extent. Perhaps I should not use the term "climatic" but "weather," since Mark Twain was once asked what kind of a climate Missouri had and he replied "Missouri has no climate; it's all weather."

At New Jersey

During the summer of 1919 here at the New Jersey Station we started considerable work with the preparation of a vaccine against these diseases. Our first step was to try to isolate the causative forms of the disease from the standpoint of the organisms found. Because of very limited equipment, personnel, and time, exhaustive work along this line was not possible. In so far as it was possible to carry it out the results seemed to check those of Dr. Brumley and Dr. Snook, referred to above, with a fair degree of accuracy. The preparation of a vaccine was attempted along the lines suggested by the Ohio investigators.

This work was done and the vaccine used on over 3,000 birds. The results were only partially satisfactory, but many important points were learned. The results of the 1919 work might be summarized as follows:

1. The preparation of a vaccine, according to this idea, does not seem feasible or practicable largely because it is not based on good theory. In other words, it is an attempt to prepare a vaccine without having found out which of the many organisms probably present in the sores on the birds was really responsible for the diseased condition. Many of the organisms found, which, of course, were contained in the vaccine as it was prepared, probably so interfered with the development of the real organism as to make the vaccine relatively useless in most instances.
2. Where this vaccine was prepared from fresh cases in an outbreak and used immediately upon preparation on the flock from which the material was taken, it seemed to have some value. In other words, something like an autogenous vaccine had been prepared. That vaccine, however, when used on other flocks seemed to do little good.

After completing considerable work along this line and after consultations with investigators at other stations, particularly Dr. Beach of California and Dr. Rettger of Yale University, it was decided to attempt work along a different line, using as a basis the outline of work suggested by Dr. Beach which has been very satisfactory under California conditions. Therefore, during the fall of 1920 vaccine of this nature was prepared, part of it from virus furnished by Dr. Beach of a California source and part of it from local cases. Something over 5,000 birds have been inoculated, among the number flocks of Leghorn pullets in which the diseases had not made their appearance, flocks of older pullets in which several cases had apeared at the time of inoculation and flocks of yearling and older hens in which the contagious eye roup and canker had appeared in a few cases. The results of this vaccination work have been studied with a great deal of care and would seem to be favorable. In other words, the preparation of the vaccine, using the scabs of the chicken pox growth, seems to be a step toward the right line of development.

The foregoing is a brief summary of the scientific work done in the investigation of the possibilities of vaccination against these diseases. No attempt is made here to describe methods of treatment of sick birds. It is assumed that it is the general consensus of opinion that the use of boric acid, tincture of iodine, and other local treatments, as well as the use of salts, tonic mashes, etc., are recognized as first-aid-to-the-injured methods that have certain value when an outbreak does occur. It is also assumed that all recognize the futility of depending upon these simple remedies to meet the situation. They are but to be used as a necessary step in handling the situation when it occurs.

From a careful consideration of the work outlined in this report it would seem that, first, there is much research work yet to be done before any method of vaccination can be built up which will be really sound and dependable; second, that sufficient work has been done and sufficient results secured to give us a good working basis, and third, that sufficient satisfactory results have been secured to warrant a consideration of adapting certain of these methods to the situation as we find it here in New Jersey.

The 1921 Campaign

Due to the natural and insistent demand of interested poultry raisers, a campaign has been instituted as an activity of our contest division and placed under the direct charge of Linden S. Dodson, a graduate in poultry husbandry from Rutgers College in June, 1921. Mr. Dodson has had experience in this work and will devote as much of his time as may be needed to the pushing of this work. It is hoped that it may result in lowering the death rate in our poultry flocks and in increasing our income from poultry farms.

General Plan

It is thoroughly understood by all parties concerned that the vaccine used in this control work carries with it no guarantee, either implied or stated. This is an experiment on the part of the parties concerned to determine if chicken pox cannot be controlled in New Jersey by vaccination the same as it has been in California and other states.

Justification for launching this campaign is found in the fact that during the fall and winter of 1919 a loss amounting to probably $1,000,000 was suffered by the poultrymen of New Jersey. Since the Vineland area is probably the largest and most intensive poultry production center in the state, we are interested in a glance at the economic aspect of the disease in that locality. Questionnaires were sent out to the members of the Vineland Poultry Association after the widespread and serious epidemic in 1919. This investigation disclosed the following facts:

Reports from 64 different producers that suffered from chicken pox in 1919 showed 52,075 birds as having had the disease with a carefully and conscientiously estimated loss of $42,000, or an average loss of $656.25 for each producer. Some people lost 600 birds out of flocks of from 1,500 to 1,800 birds, showing a mortality of 33 to 40 per cent. At this point it is important to call attention to the fact that the losses due to chicken pox are not primarily from mortality of the birds suffering from the disease, but from the following factors named in the order of their economic importance: Loss in egg production; moult caused by disease, thus stopping egg production for several months and mortality in the flock. Last year (1920), $52,000 was lost in 3 months by the Vineland people in pullets when this disease reduced the production a dozen eggs per bird for the entire 3 months. Some men who were getting 40 per cent production experienced a drop to 5 per cent. One producer states that out of 5,000 birds he had a loss of $8,000 in 2 months. On another farm in the same area the production dropped from 50 per cent to 5 per cent with only a few birds visibly affected.

The Toms River and Ocean County section has had chicken pox only for the last 3 years. Some birds under lights in this section with a production of 55 to 60 per cent dropped to 6 eggs per pen. One producer states that on 1,250 pullets he suffered a $2,200 loss due to low egg production. The mortality in his flock was practically negligible. Of the other men reporting, one figures a total loss of $3,000; and the other a loss of $1,000 on 750 birds. Still another report comes from a man who keeps 2,200 pullets and had 75 per cent of them affected. He considers his loss to be $2,600 on fall and winter eggs. The whole of Ocean County believes its loss to be $75,000 in 1919 and $80,000 in 1920. Commercial men who have matings made and incubators set before the pox strikes them have to cancel a large part of their orders for baby chicks, hatching eggs and pullets. Some poultrymen are doing pedigree breeding. If pullets that are being trap-nested lose 3 months' production, the yield secured is not a fair proof of the birds' ability as layers, thus the poultrymen cannot carry on pedigree work to advantage. New Jersey poultrymen are united in the opinion that chicken pox is the biggest economic factor working against the successful keeping of poultry today. It is likewise of serious economic importance in many other states.

The chicken pox vaccine used in this campaign is to be made available to any poultryman in New Jersey who makes a request for the vaccine on an official form, copy of which is enclosed in this circular. Vaccine will be supplied only when the conditions named in this form have been complied with. Orders will be mailed out to poultrymen in the same sequence in which they are received on the enclosed blanks.

The vaccine is to be sold at cost, the charge covering only the actual expense of the cockerels used in growing the virus, equipment necessary for laboratory use, labor, cost of preparation and postage. A tentative maximum charge of 7 cents per cubic centimeter of vaccine will be made. This figure is subject to change as experience proves the actual cost of production. It is hoped that by next fall, 1922, the cost of production will warrant a decrease in this initial price of 7 cents.

It is evident that a strictly cash basis is the only way this project can be conducted efficiently. Two cents per cubic centimeter will be paid as a deposit with the placing of the order, and 5 cents will be paid 10 days before delivery. The poultrymen will be notified by mail when the delivery will be made.

Upon receipt and acceptance of the poultrymen's order, together with a deposit of 2 cents per cubic centimeter, a receipt will be sent in acknowledgment of the order.

As to the container and package in which the vaccine will be shipped, only one size of container, or vial, will be used, a small amber or other dark glass bottle containing 20 cc. Over the neck of each bottle is placed a small rubber cap with a hole in the center which opens only when pressure is brought to bear with the syringe needle in loading the syringe previous to vaccination. The bottle will be labeled by the Squibb Laboratories, the firm who is to prepare the vaccine commercially for us. This 20-cc. container will be placed in a small wooden or paste-board box for mailing.

Cooperating Parties

The cooperating parties that will have a part in this control campaign are:

1. The department of poultry husbandry of the New Jersey Agricultural Experiment Station through its contest organization.
2. The Squibb Manufacturing Laboratories.
3. The Bureau of Animal Industry, State Department of Agriculture.
4. The poultrymen of the state interested in the problem.
5. It is hoped that the Rockefeller Research Laboratories will undertake some exhaustive research to determine the exact nature of the disease.

A Word Concerning the Part Taken by Each Party

1. The Department of poultry husbandry will prepare the virus from which the vaccine will be made. It will also exercise supervisory powers over the research and financial end of the work.

2. The Squibb Manufacturing Laboratories in New Brunswick, under Dr. J. F. Anderson, will manufacture the vaccine commercially for this project from the virus grown and furnished them by the poultry department. They will also prepare each package for shipment, and deliver it to the specialist in chicken-pox control, but orders will be received and shipment will be made only by an authorized agent designated by the poultry department.

3. The Bureau of Animal Industry at the State Department of Agriculture, under Dr. J. H. McNeill, has designated its willingness to assist in demonstrating the method of using the vaccine.

4. The poultrymen of the state interested in the campaign are requested to make accurate reports to the department on the usefulness of the vaccine.

Method of Administration

The method of administering chicken pox vaccine is very simple, and there is no reason why every poultryman in New Jersey cannot vaccinate his own flock after he has once been shown by demonstration. For the purpose of teaching the poultrymen this method the Bureau of Animal Industry, State Department of Agriculture, Trenton, is cooperating with the department of poultry husbandry, to the extent of furnishing a man to give demonstrations before poultrymen in large centers of production, and as many smaller areas as can be covered.

Besides the man from the State Department of Agriculture there will be a man from the department of poultry husbandry who will give demonstrations and lectures on the work. Evidently it will be impossible for these two above-named agencies to go into a center and vaccinate all the birds of all the men using the vaccine, nor will this be necessary, as one demonstration is all that will be required to teach the poultryman to do his own work.

All the equipment necessary for vaccination is the vial containing the vaccine and a syringe. The syringe used should be graduated in cubic centimeters and should hold as many as 10 cc. The needle should be 16 or 18-gauge and from 2 to 2½ inches in length. A screw needle is preferable.

The vaccination is made subcutaneously (under the skin). The dose is 1 cc. for each bird. The most convenient place for application is beneath the skin of the breast under the right thigh, the skin at that point being comparatively free from feathers. Special precaution must be taken that the vaccine is injected just beneath the skin, not into the pectoral, or breast muscle. The needle should be pushed along between the skin and muscle about ¾ inch to insure the vaccine, when it is discharged from the syringe, not running out of the hole made by the insertion of the needle. The syringe should be held in as nearly a horizontal plane as possible so that one can plainly see the graduations on the syringe. A quick withdrawal of the needle is necessary to prevent loss of vaccine from the needle puncture in the skin. The bird may be held either by the operator or by an assistant. When an assistant holds the bird both wings are held with the left hand and both legs with the right hand. The bird is laid on its left side with the breast toward the operator. The operator, standing a little in the rear of the bird, picks up the skin with the thumb and forefinger of the left hand and with the right hand inserts the syringe needle just beneath the skin and injects the vaccine.

One treatment is usually enough in healthy or slightly infected flocks. In badly infected flocks a second vaccination of all birds is advised. In very severe outbreaks the injections may be continued at intervals of 5 to 7 days until the disease ceases to spread. When the birds to be treated are already caught and in crates, and a man is on hand to hold the birds, an operator is able to vaccinate 175 to 225 birds per hour.

Concerning the effect of vaccination on the fowls, chicken pox vaccine if properly used never has any harmful effects. There may be a slight depression for one or two hours afterward, but as a rule there is no reaction. Vaccine has no harmful effect on the growth of young stock and therefore may be safely used on birds of any age. "Vaccine does not influence egg production." A slight decrease in egg production may result from catching and handling the birds but this should not be accredited to the vaccination. No hesitancy therefore, need be had about vaccinating heavy producing flocks. After birds are vaccinated they are released, no further attention being given them.

Price Variation of Nearly White Eggs on the New York Market

During the last 3 years the price of eggs had continued to rise in an unforeseen manner. The price for 1917-18 averaged 8.76 cents a dozen lower than 1918-19, while that year in turn averaged 8.35 cents lower than 1919-20. The peak of the market was reached in November, 1920, when that market averaged $1.03.8. The daily quotation for several days was $1.15 per dozen. From this month the price dropped more rapidly than in any of the 3 previous years and reached the lowest point that had been set for more than 4 years, in the average quotations for May, 1921, which were 34 cents a dozen. Unrest in business following the close of the war forced the prices of all commodities, including eggs, up for a while. With the noticeably fewer eggs in cold storage last winter to draw on when natural production fell off, the price reached its high figure in November, 1920, with $1.15 per dozen. About this time the tremendous grain crops of the West began to move, and poultry feeds started to go down. They are now in many places almost back to pre-war prices.

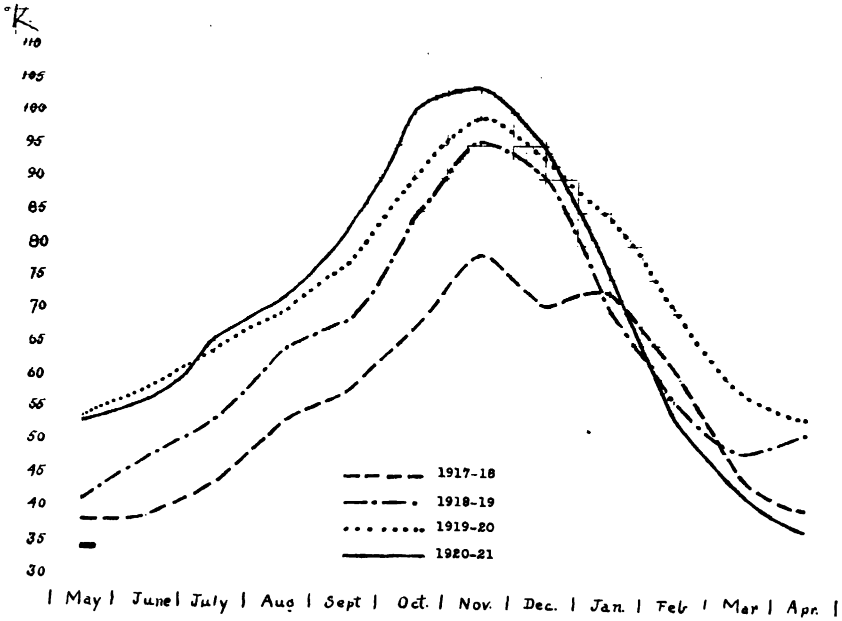

FIG. 1—GRAPH SHOWING PRICE VARIATION OF STATE AND PENNSYLVANIA NEARBY HENNERY WHITE EXTRAS.

War work in the factories has stopped and many men are out of employment. Men are looking for work of any kind and a good man for poultry work can be secured for a moderate wage. The cost of production through the lower feed costs and labor costs has dropped, so eggs can be sold cheaper than before and still give the producer the margin of profit that is due.

There is a new factor on the egg market. Since peace was declared the large number of vessels of all countries that were engaged in the transfer of war materials are looking for employment in the commercial world and give low freight rates to get business. As a result of this Chinese eggs are being shipped to this country in tremendous quantities, frozen, dried, and in the shell. These eggs are of a lower grade than the nearby eggs, but they have their indirect effect as the prices, of all grades of eggs are forced down when tremendous quantities of these eggs reach the market.

Following is the table of the monthly average of quotations on State, Pennsylvania, and nearby Western Hennery White Extras on the New York wholesale market from May, 1917, to May, 1921. Figure 1 shows graphically the contents of the table.

Table 1

Summary of Prices per Dozen of Eggs, 1917 to 1921

	1917-18	1918-19	1919-20	1920-21	1921-22
	cents	cents	cents	cents	cents
May	38.1	41.4	53.5	53.0	34.0
June	38.6	47.8	58.0	56.2	
July	43.4	53.5	64.0	65.7	
August	52.8	63.5	69.5	71.7	
September	57.7	68.3	77.0	82.2	
October	67.0	83.9	90.2	100.4	
November	78.6	95.6	99.2	103.8	
December	71.0	91.2	93.1	94.8	
January	73.2	70.8	84.2	75.7	
February	61.4	56.3	70.5	54.3	
March	45.8	49.0	58.1	43.4	
April	40.5	52.0	54.7	37.5	

Wrapping Market Eggs with Tinfoil

The problem of getting eggs to the consumer in the freshest possible condition is always before the poultrymen and others who handle eggs. The question of holding the freshness of eggs by the retarding the evaporation of moisture from them by wrapping in tinfoil has come up. Tobacco, chocolate candies, and many of our foodstuffs are kept in a fresh condition a long time by the use of a tinfoil wrapper. Cooperating with Lehmaier, Schwartz & Company, of New York City, we conducted this investigation.

Object of Investigation

The object of the investigation was to determine if eggs wrapped in tinfoil will keep their freshness longer than unwrapped eggs, and how long they can be satisfactorily kept wrapped in tinfoil, also to determine which weight of foil is best for this use.

Statement of Plan of Investigation

One dozen eggs, six of which were wrapped in tinfoil and weighed, and six not wrapped were weighed and packed, in a carton. There were 8 dozen eggs prepared this way and 1 dozen examined each week to determine its freshness and condition.

Wrapping the Eggs

Two eggs of each half dozen were wrapped in 13000 foil; two in 6500 foil, and two in a plated foil.

The 13000 foil was so thin that it contained many pinholes and tore fairly easily. It was difficult to wrap the egg in this weight of tinfoil as it would not stay in place as well as the heavier foils.

The 6500 and the plated foil handled much more easily and it adhered to the egg after it was once pressed into place by rolling it in the hands. The heavier tinfoils were more efficient in retaining the moisture of the eggs.

The eggs were kept in a cool cellar room and turned twice each week.

Results

The following table gives the weights of each wrapped half dozen and each unwrapped half dozen with the loss of weight of each, due to evaporation of moisture from the eggs.

Table 2

Weights of Lots of 6 Eggs, Showing Loss Due to Evaporation

Box Number	Dec. 14		Date	Length of Period			Loss of Weight	
	Unwrapped	Wrapped			Unwrapped	Wrapped	Unwrapped	Wrapped
	oz.	oz.			oz.	oz.	oz.	oz.
2*	12.96/128	13. 56/128	Dec. ..28	2	12.60/128	13. 44/128	36/128	12/128
3	12.11/128	12.127/128	Jan. .. 4	3	11.95/128	12.113/128	44/128	14/128
4	12.84/128	12. 52/128	Jan. ..11	4	12.12/128	12. 32/128	72/128	20/128
5	12.56/128	12. 34/128	Jan. ..18	5	11.86/128	12. 7/128	98/128	27/128
6	12.61/128	12.121/128	Jan. ..25	6	11.69/128	12. 83/128	120/128	38/128

* Box 1 not opened at one week.

In the five examinations of eggs made the air cell was always smaller in the wrapped eggs and all other characters that could be determined before the candle showed the wrapped eggs in better condition than the unwrapped.

Two eggs from each half dozen were opened on a saucer for examination, with the following results:

Albumen:

- 2 weeks—Both wrapped and unwrapped eggs showed the same thickness of albumen.
- 3 weeks—Albumen of unwrapped eggs slightly more watery than that of the wrapped eggs.
- 4th to 6th week—Same difference more pronounced.

Vitaline Membrane:

- 2 weeks—Same strength in both the wrapped and unwrapped eggs.
- 3 weeks—Slight weakening of vitaline membrane, causing the yolk to flatten slightly.
- 4 to 6 weeks—The vitaline membrane weakened in both the wrapped and the unwrapped eggs, but to a greater extent in the unwrapped eggs.

Eggs Packed Dec. 14			Eggs Examined					
			Wt. at Examination				Loss of Wt.	
Box Number	Unwrapped Wt. Oz.	Wrapped Wt. Oz.	Date Examined	Weeks	Unwrapped	Wrapped	Unwrapped	Wrapped
2	12.749	13.437	Dec. 28	2	12.468	13.343	.281	.094
3	12.085	12.991	Jan. 4	3	11.741	12.882	.344	.109
4	12.655	12.406	Jan. 11	4	12.093	12.249	.562	.157
5	12.437	12.265	Jan. 18	5	11.671	12.054	.766	.211
6	12.476	12.945	Jan. 25	6	11.538	12.648	.938	.297

Box 1 not opened Dec. 21 at 1 week.

Odor, before opening egg:

- At the fifth week there was a slight musty odor as the tinfoil was removed from the egg.
- At the sixth week this odor was more pronounced and could be dectected when the egg was opened on the saucer. The unwrapped eggs in the same cartons were free from any musty odor.

Taste:

- 2 weeks—The yolk of the unwrapped egg was slightly strong. The yolk of the wrapped egg tasted practically same as a fresh egg yolk.
- 3 to 6 weeks—Yolk tended to get stronger in both the wrapped and the unwrapped eggs, but the unwrapped egg yolks were somewhat more pronounced in this regard.
- 2 to 4 weeks—The difference in taste was only in the yolk.
- 5 weeks—There was a slight difference in taste of the albumen in favor of the wrapped egg.
- 6 weeks—There was a musty taste to the albumen of the wrapped egg.

The full boxes 1, 7 and 8 with part dozens left from the examinations were all held in the same cool cellar for 3 months and were examined before the candle on April 1, 1921.

Table 3 gives the results of this examination.

Table 3

Examination of Stored Eggs for Mold on April 1

	Unwrapped	Wrapped
Boxes 1, 7 and 8	All clear, good condition with large air cell.	Four from each box showed mold growth. Air cell very much smaller than unwrapped. Two from each wrapped in 13000 foil were clear and in good condition. Air cell between unwrapped and wrapped in size. This tinfoil was not tight enough to hold the moisture inside the covering.
Box 2	2 examined Dec. 28 4 held to April 1 All clear	2 examined Dec. 28 4 held to April 1 1 moldy, 3 clear
Box 3	2 examined Jan. 4 4 held to April 1 All clear	2 examined Jan. 4 4 held to April 1 4 moldy, 0 clear
Box 4	2 examined Jan. 11 4 held to April 1 All clear	2 examined Jan. 11 4 held to April 1 2 moldy, 2 clear
Box 5	2 examined Jan. 18 4 held to April 1 All clear	2 examined Jan. 18 4 held to April 1 4 moldy, 0 clear
Box 6	2 examined Jan. 25 4 held to April 1 All clear	2 examined Jan. 25 4 held to April 1 3 moldy, 1 clear

The examination of boxes 1, 7 and 8, in which all eggs wrapped in 13000 foil were clear and free from mold, shows that the irregularity of the mold in the eggs that had been wrapped part time was due to the random selection of 2 eggs to open for examination on the saucer. Holding the eggs past the date of their examination shows that a mold had started to grow on and through the shell but was not detected when they were unwrapped and examined before the candle for size of air cell. This mold continued to grow after the eggs were unwrapped. The amount of mold growth varied from spots the size of a pin point to more than three-quarters of the entire outside surface of the egg, when this was wiped off, the pores in the egg shell through which the mold had grown were purple in color.

Cause of the Mold

The moisture of the egg tended to pass through the pores of the shell in the normal way and in normal amounts. This moisture was retained next to the eggs and inside the tinfoil covering. This confined moisture softened the gelatinous coating on the outside of the egg and made a good place for mold spores to grow, and as mold spores are present everywhere the mold growth appeared on the egg.

Conclusions

Wrapping market eggs in tinfoil is evidently not a practice that will aid in holding them in good condition in storage, even for a short time.

Characteristics of the Layer

The studies pertaining to methods of judging and culling fowls based on their external character have been continued, the main object being to develop some of their finer points or organize the whole scheme of observation so that proper weight is given to the respective sections. The poultry husbandman attended the Culling School at Cornell University as a member of the staff and there, in cooperation with other departmental representatives from the leading agricultural Colleges in the United States and Canada, developed the following revised schedule which is here published as a matter of record, and for the benefit of the commercial poultrymen of the state:

In order to lay well a bird must have a sound body. As a first consideration a bird must be *vigorous and healthy.* Vigor and health are shown by a bright, clear eye, a well set body, a comparatively active disposition and a good circulation.

Further, the bird must be free from physical defects such as crooked beak, excessively long toe nails, eyelids that overhang so that the bird cannot see well, scaly leg or anything else that would keep the bird from seeing or getting an abundance of food.

Age, condition, feed, and range should be considered in culling a flock.

Type

The type of a bird indicates the degree of intensity with which it can lay. Type can be applied to any breed, age or sex or condition at any time of year.

In order to make a record a hen must lay not only long but heavily. In order to lay heavily she must have sufficient body capacity to digest large amounts of food rapidly. Large capacity in a laying hen is shown by a body that is relatively deep. The under line should be fairly straight and the back should be comparatively horizontal.

The Back

The back should be flat and wide and its width should be carried well back to the tail. The back that tapers decidedly or slopes down indicates poor capacity.

The breast should be full, deep and prominent. The neck should be fairly short and well set. The legs should be of moderate length. The long-legged, round-shanked, knock-kneed, scrawny, hump-backed, long-necked, bony or crow-headed individual is not a good layer.

PLATE 1.

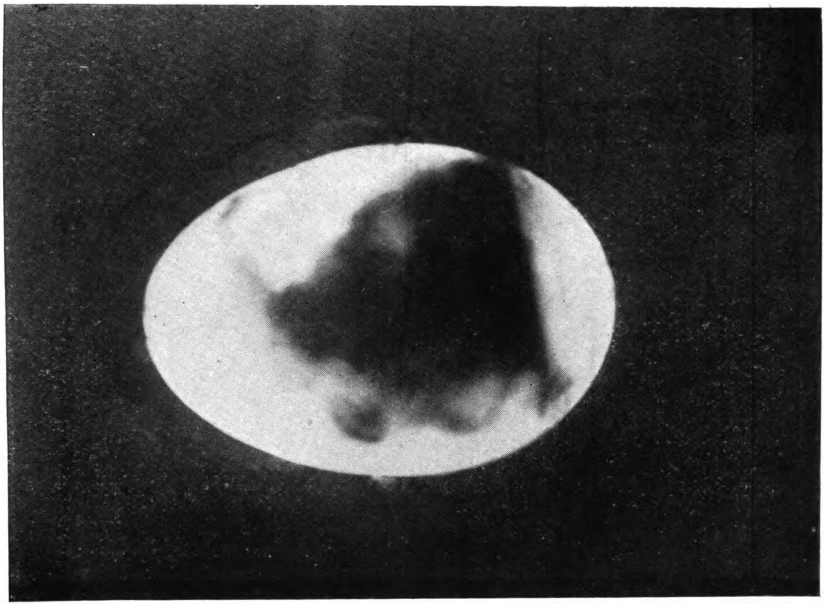

FIG. 1. PHOTOGRAPH OF EGG SHOWING MOLD GROWTH ON THE INTERIOR OF THE SHELL.

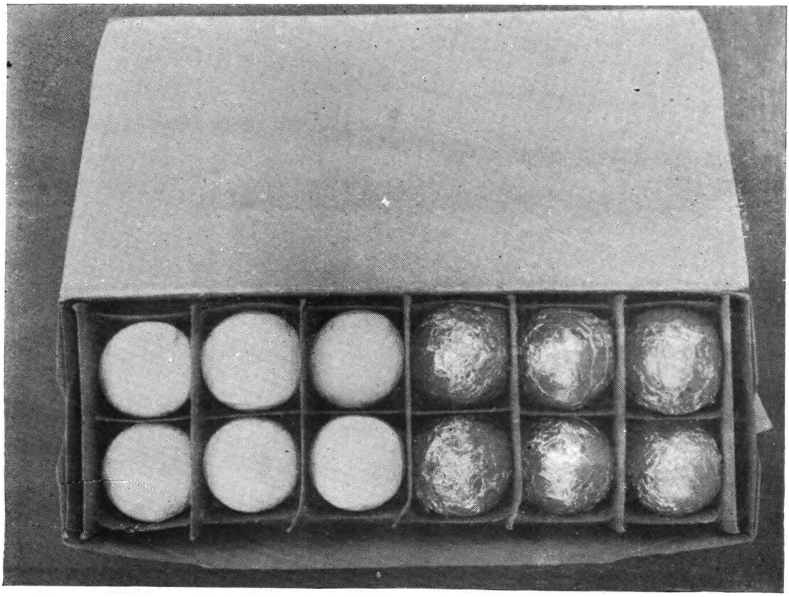

FIG. 2. PHOTOGRAPH SHOWING EGGS WRAPPED IN TINFOIL AS USED IN EXPERIMENT ON PRESERVATION METHODS.

The keel bone should be long and generally curved. This frequently means that the abdomen of a good male will be small rather than large.

The head should be moderately fine with large, bold eyes, set well out on the head in an oval eye socket. A fat headed, small round-eyed or cross-eyed bird or one with overhanging eyebrows, or having a comb with extremely narrow serrations is not likly to be a good layer.

Long narrow feathers indicate a late maturing bird. Care should be taken not to confuse a bird that appears deep because of long, loose feathering, with one that has an actual bone and flesh depth.

Depth and slab-sidedness may be measured by placing the thumbs on the middle of the back, the little fingers on the front end of the keel bone and the middle finger on the rear end of the keel bone. Press in with the palms of the hands and do not squeeze the bird up with the fingers. The deeper and more slab-sided the bird feels, the better. It is relative depth that is desired and not actual depth. A big hen may be actually deep and yet relatively shallow and hence the poor layer. Relative depth of front to rear of body may be measured by spanning the body with the thumb and middle fingers from back to breast and sliding the fingers and thumb along the keel and back.

Body Changes Due to Laying

The laying hen has a large, moist vent showing a wide dilated condition and looseness as compared with the hard, round, puckered vent of a hen that is not laying.

The whole abdomen as well as the vent is dilated so that the pelvic arch is widespread and the keel is forced down, away from the pelvic arch. The more eggs a bird is going to lay the following week the greater will be the size of the abdomen. The actual size of the abdomen is influenced by the length of the keel, the size of the eggs laid, and the size of the bird. A sagging abdomen is undesirable.

Heavy production is shown by the quality of the skin and the thickness and stiffness of the pelvic bones. Fat goes out from the skin and body with production so that the heavy producers have a soft velvety skin that is not underlaid by layers of hard fat. The abdomen in particular is soft and pliable. The sternal processes are very prominent and are generally bent upward. The thicker and blunter the pelvic bones and the greater the amount of hard fat in the abdomen, the less the production or the longer the time of production.

Changes in Secondary Sexual Characters

The comb, wattles and ear lobes enlarge or contract, depending on the ovary. If the comb, wattles and ear lobes are large, full, plump and smooth, or hard and waxy, the bird is laying heavily. If the comb is limp the bird is only laying slightly, but is not laying at all when the comb is dried down, especially at molting time. If the comb is warm it is an indication that the bird is coming into production.

Loss of Fat Due to Laying

Color or pigmentation changes. (These should be observed by daylight.) A laying fowl uses up the surplus fat in the body, especially it removes the fat from the skin. In yellow-skinned breeds this loss of fat and pigment can readily be seen by the loss of the yellow color. The different parts of the body tend to become white according to the amount of fat stored in the body and the amount of circulation of blood through those parts. The changes occur in the following order:

The vent changes very quickly with egg production so that a white or pink vent on a yellow-skinned bird generally means that the bird is laying, while a yellow vent means the bird is not laying. It should be recognized that all yellow color changes are dependent on the feed, coarseness of the skin, and size of the bird. A heavy bird fed on an abundance of green feed or other material that will color the fat deep yellow will not bleach out nearly as quickly as a smaller or paler colored bird. A heavy bird fed on an abundance of green feed or other material that will color the fat deep yellow will not bleach out nearly as quickly as a smaller or paler colored bird. A bird with lustrous shanks does not fade as quickly as a dull shanked bird.

The eyering, that is the inner edges of the eyelids, bleaches out a trifle slower than the vent. The earlobes on Leghorns and Anconas bleach out a little slower than the eyering, so that a bleached earlobe means a little longer or greater production than a bleached vent or eyelid.

The color goes out of the beak beginning at the base and gradually disappears until it finally leaves the front part of the upper beak. The lower beak bleaches faster than the upper but may be used where the upper is obscured by horn or black color. On the average yellow-skinned bird, a bleached beak means heavy production for at least the past 4 to 6 weeks.

Molting

When a bird stops laying in the summer she usually starts molting. The later a hen lays in the summer, or the longer the period over which she lays, the greater will be her production, so that the high producer is the later layer and hence the later molter. The length of time that a hen has been molting or has stopped laying can be determined by the molting of the primary feathers. It takes about 6 weeks to renew completely the primary feathers next to the axial feathers and an additional two weeks for each subsequent primary to be renewed. One or more growing feathers of the same length should be counted as one feather.

Temperament and Activity

A good layer is more active, intelligent, and friendly and more easily handled than a poor layer. A low producer is shy and flighty and stays on the edge of the flock and will squawk when caught.

REPORT OF THE DEPARTMENT OF DAIRY HUSBANDRY

Department of Dairy Husbandry

WILLIAM M. REGAN, A.M., *Dairy Husbandman.*

FORREST C. BUTTON, B.SC., *Assistant Dairy Husbandman.*

JOHN HILL, B.SC., *Assistant Dairy Husbandman.*

*__JOHN DONKER__, *Head Dairyman.*

†**DONALD BAKER**, *Head Dairyman.*

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*Resigned June 15, 1921.
†Appointed June 15, 1921.

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Report of the Department of Dairy Husbandry

WILLIAM M. REGAN

The activities of the department of Dairy Husbandry for the year ending June 30, 1921, may be listed as follows:

1. *Experimental.* Data have been gathered on eight different experimental projects.

2. *Extension.* The department of dairy husbandry, cooperating with the department of extension, has given advice and assistance to the dairymen of the state through meetings, correspondence, and personal visits. During the last half of the year two extension specialists in dairying have been employed on full time. On June 30, 1921, there were 6 active bull associations, 8 active cow-testing associations, 3 active state breeders' associations and 7 active local breeders' associations. Feeding demonstrations and extension dairy schools have been successfully carried on.

3. *Advanced registry.* The amount of advanced registry work done was practically the same as last year. More tests were conducted last year than had ever been supervised by the department before. The year just closed showed a slight increase in the amount of semi-official testing done and a slight decrease in the number of short-time tests made.

4. *Creamery inspection.* An excellent law together with adequate funds has made possible an organized inspection that has resulted in protecting the farmers against unscrupulous purchasers of milk and has served to create a better feeling between the buyer and seller of milk where the percentage of butterfat is used as the basis for payment. Six thousand five hundred and twenty-eight pieces of glassware were calibrated by this department. Two prosecutions were brought and successfully terminated in cases where creamerymen failed to observe the law.

Two hundred and sixty-one individual inspections were made of 109 milk plants. A total of 2,043 samples were check-tested.

SUMMARY OF CREAMERY INSPECTION

The results of the first year of organized creamery inspection are most gratifying, if the number of complaints and samples received for testing is an index to the efficiency of the work. Table 1 shows the number of samples sent in by farmers for butterfat tests during the past 3 years. The number of complaints against milk plants *also* is noted.

Table 1

Butterfat Tests and Complaints Against Milk Plants

	1919	1920	1921
Number of samples sent into office by farmers	422	48	29
Number of complaints received against tests of milk plants	87	11	5

Table 2 shows the actual number of milk-receiving stations visited and the number of composite samples check-tested (July 1, 1920-June 30, 1921).

Table 2

Milk Receiving Stations Visited and Samples Tested

COUNTY	Number of Creameries	Number of Inspections	Number of Samples Tested
Burlington	8	12	96
Camden	4	3	0
Hunterdon	30	54	312
Mercer	4	7	60
Middlesex	3	7	36
Monmouth	1	3	24
Ocean	1	3	18
Salem	10	28	168
Somerset	6	15	96
Sussex	26	92	820
Warren	16	37	413
Total	109	261	2043

A comparison of the results of the inspection work can best be noted by studying table 3. Favorable changes in conditions in the creameries of the respective counties will be noted between the first and last inspections of the year.

Table 3

Statistics Showing Compliance with Creamery Inspection Law

COUNTY	Standard Glassware (S. G. N. J.) not in Use		Licensed Tester not Employed		Composite Samples not being Taken Daily		Composite Samples not being Kept after Testing		Samples not Tested on Premises where Taken	
	July 1920	June 1921	July 1920	June 1921	July 1920	June 1921	July 1920	June 1921	July 1920	June 1921
Camden	......	......	......	......	......	......	......	......	......	......
Essex	......	......	......	......	......	......	......	......	1	0
Hunterdon	5	1	5	1	4	2	2	1	3	0
Mercer	......	......	......	......	1	0	......	......	......	......
Middlesex	......	......	......	......	1	1	......	......	......	......
Monmouth	......	......	......	......	......	......	......	......	......	......
Ocean	......	......	......	......	......	......	......	......	......	......
Salem	4	0	1	0	4	1	4	0	2	0
Somerset	......	......	2	0	2	1	1	0	2	0
Sussex	4	0	1	0	5	2	3	0	4	0
Warren	3	0	......	......	1	0	......	......	1	0
Burlington	3	0	......	......	1	0	......	......	......	......
Total	19	1	9	1	19	7	10	1	13	0

Prosecutions were instituted against two milk plants that persisted in violating the law. These cases were prosecuted by the attorney-general.

Table 4

Inspection of Glassware, 1920-1921

	Total Number of Pieces	Number Incorrect	Per cent Incorrect
Milk-test bottles	4421	27	0.61
Cream-test bottles	1128	5	0.44
Pipettes	979	0	0.00
Total	6528	32	0.49

Table 4 shows the number of milk and cream test bottles and pipettes inspected and the percentage of each which were found incorrect for the past year.

It was found on inspection in 1916 that 7.6 per cent of the glassware sent in was inaccurate. During the second year of inspection 3.87 per cent was inaccurate. In 1918-19, 1.7 per cent was inaccurate, and in 1919-20, 0.502 per cent. The above table shows that during the past year but 0.49 per cent of the inspected glassware was inaccurate.

These results bring out conclusively that the glass companies are sending only their best glassware into the state. Careful inspection is insuring the farmers against any inferior or inaccurate glassware being used in determining the fat content of the milk that they sell.

ADVANCED REGISTRY

The following summary records the amount of work done by this department for the pure-bred dairy cattle breeders of New Jersey during the year ending June 30, 1921, and shows a total of 693 records supervised. During the preceding year the number of records supervised totaled 796. This is a decrease of 103 records. In the preceding year there was an increase of 276 records.

Cows tested semi-officially:

Jersey	159
Guernsey	248
Ayrshire	23
Shorthorn	5
Holstein	135
	570

Number

7-d
14-d
30-d
60-d
90-d
100-d
120-d
Num
Num
Tota
Num
Num

During
culosis-fre
was 12.5 q
was secure
of heifers

The am
an average
sale of mi
service fe
total sales.

Cows ....
Heifers and
Bulls ....
Total

Number of semi-official tests	2,252
7-day records	232
14-day records	11
30-day records	29
60-day records	6
90-day records	4
100-day records	1
120-day records	1
Number of breeders doing semi-official testing	49
Number of breeders doing official testing	46
Total number of breeders doing testing	95
Number of supervisors used for official tests	33
Number of supervisors used for semi-official tests	25

DAIRY HERD AND EQUIPMENT

During the year the Experiment Station has maintained a tuber-losis-free accredited herd of dairy cattle. The average production as 12.5 quarts per day per cow. This is a smaller production than as secured during the previous year because of the larger proportion heifers milking.

The amount of milk sold during the year was 146,367 quarts at average price of 13.2 cents per quart, making the income from the le of milk $19,366.08. The sale of stock, miscellaneous sales and rvice fees gave the department an income of $20,077.08 from tal sales.

Table 5

Inventory of Dairy Herd, June 30, 1921

	Jersey	Holstein	Ayrshire	Guernsey	Milking Shorthorn	Dexter-Kerry	Grades
ws	13	11	10	6	4	2	11
eifers and calves	12	5	5	2	0	0	3
lls	5	3	1	3	1	0	..
Total	30	19	16	11	5	2	14

The following animals were donated to the Agricultural College during the year:

3 Dexter-Kerry cows, donated by H. F. Sinclair, Rancocas Stock Farms, Jobstown, N. J.
1 Pure-bred Guernsey cow and calf donated by Mrs. Paul Moore, Hollow Hill Farm, Convent, N. J.
1 Guernsey cow, donated by L. F. Loree, Bowood Farms, West Orange, N. J.
2 Guernsey bull calves, donated by L. F. Loree, Bowood Farms, West Orange, N. J.

NEEDS OF THE DEPARTMENT

The needs of the department may be summarized as follows:

1. Dairy Building adequately equipped.
2. Milking barn.
3. Milk house.
4. Work-shop and store-room.

FACTORS AFFECTING THE TOTAL BUTTERFAT CONTENT OF COWS' MILK DURING A PERIOD OF 2 DAYS

In the supervision of advanced registry tests the New Jersey Agricultural Experiment Station requires that its supervisor shall see that each cow is "milked dry" at the milking preceding the test period. The supervision of this preliminary milking costs the breeders of pure-bred dairy cattle in New Jersey approximately $2,500 each year.

The breed associations and some of the breeders have raised a question as to the necessity of the preliminary milking as a measure in the safeguarding of the honesty and accuracy of the test. At the last meeting of the Dairy Science Association it was found that out of 11 states, 7 require no preliminary milking, 2 leave the matter to the discretion of the superintendent of Advanced Registry of the State, and only 2 require a preliminary milking. It is their claim that thoroughness of milking would not be a factor affecting subsequent tests and consequently the expense is a needless one. It was for the purpose of obtaining information on this point that the following outlined experiment was planned.

Outline of Experiment

The experiment involved the use of 4 cows in the college herd, two Holsteins, one Jersey, and one Ayrshire. The animals were selected as far as possible with regard to uniformity of stage of lactation and gestation, age and the quantity of milk produced.

The feeding, housing and general care of the animals did not differ from that of the college herd.

Accurate account was kept of all feed consumed by each of the animals. The weight, height at withers and heart-girth measurements were taken every 30 days in order to have a check in case of any difficulties arising during the experiment. The cows were milked dry twice daily for 6 days. On the morning of the seventh day only half of the milk was drawn and during the four subsequent milkings the cows were again milked dry.

Samples were taken at each milking and tested for butterfat. In this way it was possible to obtain an accurate comparison between the average butterfat test before and after the partial milking. This procedure was repeated 27 times with the 4 cows.

It will be noted that tables 6, 7, 8 and 9 do not give the data for every day throughout the experimental period, but only for the milkings which have a direct bearing on the results of the trials and only for those trials in which approximately half of the milk was drawn during the milking at which such a procedure was planned. At the beginning of the experiment milking machines were used, but it was found difficult to calculate the point at which half the milk had been drawn. For this reason it was found advisable to use only hand milking and one man was placed in charge of the animals. In this way more careful attention was given to the milking. This man also did all of the testing, thereby eliminating as far as possible any chances of error which might arise through different methods of conducting the Babcock test.

Presentation of Data

Tables 6, 7, 8 and 9 show the pounds of milk produced, the per cent of butterfat and the pounds of butterfat produced by each cow during the 4 milkings immediately preceding the partial milking, for the partial milking and during the 4 milkings immediately following the partial milking. Tables 10 and 11 were derived from tables 6, 7, 8 and 9 and show more clearly the result of the partial milking.

The Effect on the Percentage of Fat

The 108 milkings following the 27 partial milkings showed an average test of 0.27 per cent higher than the 108 milkings preceding the 27 partial milkings. It will be noticed that during some of the trials there was a slight decrease in the percentage of fat, but each of the 4 animals showed an increase when all of the trials were considered. The figures apparently show no preference to breed in that one Holstein made an average increase of 0.425 in the percentage of butterfat while the other made only 0.154 per cent increase. However, the average for these two animals was higher than for either the Jersey or the Ayrshire. The increase in the fat percentage shown by the Jersey and Avrshire averaged 0.380 and 0.124, respectively.

The average increase of 0.27 per cent in fat would not seem very large. However, in the case of a cow producing 20,000 pounds of milk per year this increase of 0.27 per cent would add 54 pounds to her yearly butterfat production. During several of the trials the increase was far in excess of the average. Table 5 shows that in one trial there was an increase of over 0.6 per cent and in 10 others there was an average increase of over 0.53 per cent. Taking this into consideration the data collected would indicate that while the average for all trials was only 0.27 it would be possible, however, to obtain a much larger increase in the percentage of butterfat.

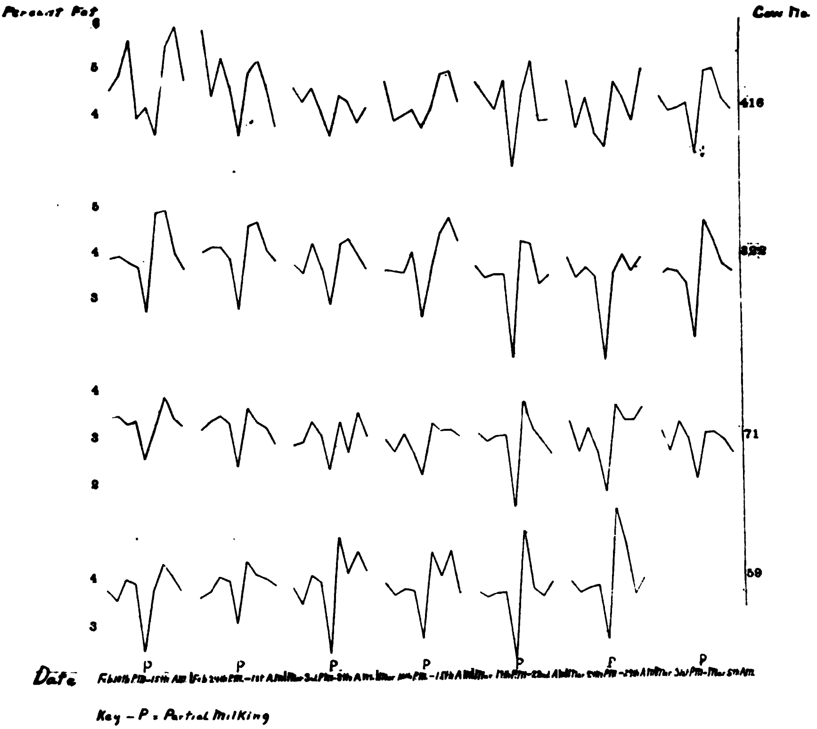

FIG. 1. GRAPH SHOWING FAT TESTS BEFORE AND AFTER PARTIAL MILKING.

Figure 1 reveals an interesting feature of the experiment. It would be expected that the highest fat percentage would be reached at the milking following the partial milking. The graph shows that this is not always the case, since out of the 27 trials there were 12 in which the butterfat percentage was higher at the second milking than it was for the milking immediately following the partial milking.

The Effect on the Production of Milk

The average milk production for the 108 milkings following the 27 partial milkings was 0.766 pounds more than the 108 milkings preceding the 27 partial milkings.

The average production of the 4 cows before the partial milking was 10.98 pounds. On the average, 3.8 pounds of milk were left in the udder of each cow at the partial milkings. Since there was an increase of only 0.766 pounds of milk, it is assumed that the rest of the milk was either reabsorbed in the udder or that milk secretion was temporarily checked, or possibly both were factors affecting the 4 subsequent milkings.

Table 12 is interesting though possibly not conclusive in view of the fact that only 4 cows were used.

Table 12

Milk Left in Udder Estimated in Percentage of Normal Production Compared with the Average Increase in the Percentage of Fat

Number of Cow	Average Milk Production	Milk Left in Udder	Increase in Per cent of Fat	Milk Left in Udder
	lbs.	lbs.	per cent	per cent
59	11.31	4.13	0.425	36.5
322	8.77	2.97	0.380	33.8
71	14.92	6.18	0.154	41.3
416	8.95	3.52	0.124	39.3

According to the figures shown in table 12 the cows which had the least milk left in the udder at the partial milking showed the highest increase in the percentage of butterfat. It would seem from this that by leaving too much milk in the udder there would not be an increase in the percentage of fat, but that by leaving a certain percentage of milk in the udder the maximum increase would be obtained.

Summary

It was found possible in this experiment to increase the percentage of butterfat in milk during a period of 2 days by leaving half of the milk in the udder during the milking prior to the 2-day period. Although the average increase in the percentage of butterfat was only 0.27, the data collected would seem to indicate that it is possible to get an increase of over 0.5 in the percentage of butterfat.

The highest fat percentage was not always reached at the milking following the partial milking. Out of the 27 trials there were 12 in which the highest fat percentage was reached the second milking after the partial milking.

If in advanced registry work a practice was made of leaving a part of the milk in the udder prior to the 2-day test, our figures would indicate that such a practice could not be detected by a study of the cows' milk record, since there was an average increase of only 0.766 pounds of milk for the period following the partial milking.

The data collected in this experiment indicate that a preliminary milking is necessary as a measure in the safeguarding of the honesty and accuracy of advanced registry testing.

Table 10

Differences between Milk and Fat Production and Percentage of Butterfat Before and After Partial Milking

Cow 416

Trial No.	Milk	Fat	Butterfat
	lbs.	per cent	lbs.
1	+0.4	+0.26	+0.0438
2	—0.3	—0.36	—0.0471
3	+0.3	—0.16	—0.0036
4	+2.2	+0.30	+0.1362
5	+1.0	—0.07	+0.0402
6	—0.2	+0.46	+0.0282
7	+2.6	+0.44	+0.1624

Cow 322

1	.....	+0.57	+0.0537
2	+0.9	+0.27	+0.0753
3	+0.1	+0.25	+0.0254
4	+0.9	+0.46	+0.0790
5	+2.2	+0.30	+0.1296
6	+0.6	+0.17	+0.0421
7	+1.5	+0.64	+0.1336

Cow 71

1	—1.7	+0.05	—0.0524
2	+1.8	—0.08	+0.0500
3	+1.1	+0.12	+0.0548
4	+2.2	+0.34	+0.1264
5	+2.3	+0.13	+0.0954
6	+0.8	+0.60	+0.1182
7	+2.3	—0.08	+0.0594

Cow 59

1	—0.8	+0.17	—0.0131
2	+0.1	+0.23	+0.0300
3	—0.3	+0.64	+0.0625
4	+1.2	+0.46	+0.1012
5	+0.6	+0.44	+0.0760
6	—0.3	+0.61	+0.0486

NOTE: + = Increase of Post Period over Pre. Period.

Table 11

Average Increase in Milk and Butterfat Production and Percentage of Fat for Each Individual During 7 Trials

Cow No.	Milk	Fat	Butterfat
	lbs.	per cent	lbs.
59	0.08	0.425	0.0508
71	1.25	0.154	0.0645
322	0.88	0.380	0.0769
416	0.86	0.124	0.0514
AVERAGE	0.77	0.270	0.0609

REPORT OF THE DEPARTMENT OF SEED ANALYSIS

Department of Seed Analysis

JESSIE G. FISKE, M.Sc., *Seed Analyst.*

*__A. T. PERKINS__, B.Sc., *Assistant in Legume Inoculant Analysis.*

†**DOROTHY SILBERT**, A.B., *Assistant Seed Analyst.*

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*Appointed July 1, 1920.
†Appointed September 1, 1920.

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Report of the Department of Seed Analysis

JESSIE G. FISKE

The functions of the department during the fiscal year 1920-21 proceeded along the usual lines of development. Samples of all kinds have been analyzed for purity and germination and a report of their value forwarded to parties interested. Many farmers, as well as dealers, are availing themselves of the free analytical service of the seed department. This feature of the departmental work seems to be appreciated alike by growers and seedsmen, and to the mind of the writer is perhaps the most beneficial service the department can render. The keen interest which the majority of dealers have shown in the analyses and general quality of seeds tested in this department, is a factor which should not be overlooked by any who seek to promote this line of endeavor. Every possible effort will be made to retain and increase this evident interest.

The existence of the seed law is gradually being felt in most sections of the state. A more complete knowledge of its significance and value has been noted by the inspectors and state seed analyst in their visits to various seed firms. The feeling is quite general that the department gives invaluable information to the retail vendor. From the seed laboratory tests he can determine what purchases to make from wholesale merchants and can be certain that their guarantees actually specify quality.

UNOFFICIAL SAMPLES

Under this heading are included 1,338 samples of seed, sent in by farmers, dealers and other residents of the state. These samples represent the average quality of seed offered for sale in the open market. Consequently, they vary within wide limits. In general, it is believed that the average percentage is relatively high, as table 1 indicates.

OFFICIAL SAMPLES

Samples of seeds collected by inspectors or the state seed analyst are included under this title. During the past year the fertilizer inspectors, Messrs. Purrington and Beckwith, have conducted a portion of the inspection work, with a view to lessening the expenditures entailed in covering practically the same sections of the state in seed and fertilizer inspection. In addition, the state seed analyst has collected a number of samples from the large warehouses of wholesale firms where insufficient time did not permit the inspectors to do so. Inspection has been more thorough and searching than usual. However, this phase of the work cannot be conducted with too great care as it is obvious that the enforcement of the law is absolutely dependent upon it. There is a considerable amount of unlabelled stock on the market. This is to be expected and will exist until the inspection is complete and the purchaser has become insistent upon the test label. The enforcement of the law is an educative as well as a control problem. Although the fiscal year terminates June 30, it seems advisable to delay the publication of the results of seed inspection until later in the year, as it will mean the splitting of the season's records which would be a decided disadvantage in many respects.

Table 1

Number of Unofficial Samples Tested, 1920-21

SEED	Number	Average Purity	Average Germination
		per cent	per cent
Grasses and Cereals			
Timothy	57	99.49	89.71
Redtop, fancy	11	85.66	72.40
Redtop, chaffy	3	35.88	23.00
Orchard grass	2	65.81	37.75
Kentucky blue-grass	9	78.32	58.66
Canada blue-grass	5	81.34	54.80
Red fescue	5	90.01	54.60
Other fescue species	6	81.86	45.66
Miscellaneous grasses	15	90.97	48.80
Grass mixtures	11		
Millet	8	97.65	63.12
Rye	15	96.39	80.90
Oats	5	98.72	95.90
Wheat	5	97.46	88.20
Leguminous Forage Crops			
Alfalfa	63	98.47	81.39
Alsike clover	50	98.63	86.71
Red clover	62	97.68	88.74
Crimson clover	29	96.94	88.10
White clover	7	96.04	84.57
Sweet clover	17	95.82	64.53
Mixed clover	1	97.50	88.00
Vetch	38	98.83	69.15
Soybeans	8	94.85	82.25
Field peas	7		96.42
Cowpeas	14	95.55	76.35
Miscellaneous Forage Crops			
Rape	7	97.91	79.08
Broom corn	1	93.46	47.50

Table 1 (Continued)

SEED	Number	Average Purity	Average Germination
		per cent	per cent
Vegetables			
Asparagus	1		35.00
Beans	89		82.48
Beets	43		55.43 bolls 134.60 sprouts
Cabbage	189		86.31
Carrot	34		59.79
Cauliflower	7		65.75
Celery	30		56.50
Chevil	1		59.50
Chicory	1		53.00
Collards	2		74.25
Sweet corn	28		84.57
Corn salad	2		46.50
Cucumber	23		84.19
Cress	2		51.75
Dill	3		52.00
Eggplant	14		57.13
Endive	5		54.00
Kale	5		97.30
Kohlrabi	3		78.16
Leek	6		65.66
Lettuce	21		72.50
Muskmelon	15		77.90
Onions	22		78.38
Parsley	5		59.40
Parsnips	1		90.00
Peas	36		86.19
Pepper	54		61.07
Pumpkin	5		88.40
Radish	27		91.50
Salsify	3		93.33
Spinach	23		68.50
Squash	28		67.25
Swiss chard	6		56.45 bolls 137.06 sprouts
Tomato	42		84.69
Turnip	14		82.00
Watermelon	10		68.20
Flowers			
Miscellaneous flowers	17		54.64
Total	1338		

PLANT IDENTIFICATION

There is a continued and increasing demand for the identification of weed plants and weed seeds. Methods of weed eradication also have been forwarded, especially in the case of the so-called noxious weeds.

Table 2 gives the list for the year.

Table 2

Identification of Plants

Common Name	*Botanical Name*	*Source*
Horsetail	*Equisetum arvense*	Mount Holly
Panic grass	*Panicum sp.*	Somerville
Herd's grass	*Agrostis alba*	Somerville
Velvet grass	*Holcus lanatus*	Toms River
Velvet grass	*Holcus lanatus*	Somerville
Bermuda grass	*Cynodon Dactylon*	Lambertville
Canada blue grass	*Poa compressa*	Somerville
Rye grass	*Lolium perenne*	Somerville
Rye grass	*Lolium perenne*	Englishtown
Witch grass	*Agropyron repens*	Mullica Hill
Little prickly sedge	*Carex sterilis*	Somerville
Muhlenberg's sedge	*Carex Muhlenbergii*	Somerville
Blackberry lily	*Belamacanda chinensis*	Stockton
Sheep sorrel	*Rumex Acetosella*	Bayonne
Lamb's quarters	*Chenopodium album*	Bayonne
Common pigweed	*Amaranthus retroflexus*	Bayonne
Knawel	*Scleranthus annus*	Summit
Knawel	*Scleranthus annus*	Little Falls
Night flowering catchfly	*Silene noctifolia*	Philadelphia
Night flowering catchfly	*Silene noctifolia*	Morristown
Night flowering catchfly	*Silene noctifolia*	Bridgeton
Field cress	*Lepidium campestre*	Bridgeton
Wild turnip	*Brassica campestris*	Bridgeton
Honesty	*Lunaria annua*	Newton
Rabbit's foot clover	*Trifolium arvense*	Flemington
Rabbit's foot clover	*Trifolium arvense*	Bayonne
White sweet clover	*Melilotus alba*	Glenwood
Blue or cow vetch	*Vicia cracca*	Madison
Fringed milkwort	*Polygala pauicolia*	Newfoundland
Willow or hairy herb	*Epilobium hirsutum*	Jersey City
Wild morning glory	*Ipomoea pandurata*	Haddonfield
Morning glory	*Ipomoea barbigera*	Belvidere
Ground moss pink	*Polemonium sp*	Paterson
Blue weed	*Echium vulgare*	Maplewood
Pennyroyal	*Hedeoma pulegioides*	Jersey City
Northern bedstraw	*Galium boreale*	Lakehurst
Horse nettle	*Solanum carolinense*	Caldwell
Pentstemon	*Pentstemon Digitalis*	Sussex
Ragweed	*Ambrosia artemisaefolia*	Bayonne
Canada thistle	*Carduus arvensis*	Woodbury
Cynthia	*Krigia amplexicaulis*	Newton

LEGUME INOCULATION

A number of tests of legume inoculants have been made by this department during the year 1920-21. The work is practically a continuation of that done by C. R. Fellers, in 1917, and except for a few minor changes, laboratory technique has been carried out as described by him in Soil Science (v. 6, no. 1, p. 53). Two types of samples have been examined, unofficial samples, those obtained from farmers, etc., in the state, and official samples, obtained by a representative of this department from local dealers selling this material.

The unofficial samples herein described have been purchased, for the most part, through farmers, by the cooperation of the county agents. In this way, samples have been secured from all parts of the state which are representative of the material offered for sale in the market. Samples prepared by the following companies have been tested: Standard Inoculant Company, Earp-Thomas Company, O. M. Scott & Sons, Alphano Humus Company, Westrobac Company, a total of 32 samples.

Table 3 gives the results of these tests.

On the whole, the laboratory and greenhouse tests have indicated that the samples are of a high grade. The majority of samples sold in agar cultures have been pure, although this fact is not an absolute criterion of quality. Practically all of the cultures have contained a relatively high number of viable organisms and, without exception, the cultures have had the power to infect the crop or crops for which sold. In a few cases, cultures have been found to violate one or more of the six principles of the law, but quite frequently these samples have been carried over from the previous year. An effort is being made to eliminate this stock from the market. The principal violations have been to neglect the placement on individual containers of the date of preparation and the date beyond which the contents would be of doubtful value. However, conditions have improved to a large extent since the manufacturers' attention has been called to the existence of the law.

In addition to the regular routine of analysis, the department is carrying on field experimentation for the purpose of comparing greenhouse conditions with those in the field. An attempt is also being made to determine the relation between the hydrogen concentration of the soil, and the power of the organism to infect the host. An investigational study of the various methods of inocculating seeds is under consideration.

For sake of uniformity, and in order that a complete statement may be made concerning the official samples collected for the year, it would seem advisable to print the results at a later date in conjunction with the official seed samples.

Table 3 Results of Tests of Legume Inoculants

COMPANY	MEDIUM	VARIETY OF LEGUME	SIZE	NUMBER OF ORGANISMS PER CULTURE	PURITY	ABILITY TO AFFECT HOST
Earp-Thomas	Agar	Vetch	¼ acre	15,750 M*	Pure	O. K.
Earp-Thomas	Agar	Vetch	¼ acre	27 M	Pure	O. K.
Earp-Thomas	Agar	Vetch	¼ acre	52 M	Pure	O. K.
Earp-Thomas	Agar	Vetch	¼ acre	32 M	Pure	O. K.
Earp-Thomas	Agar	Crimson clover	¼ acre	7,680 M	Pure	O. K.
Earp-Thomas	Agar	Cowpeas	¼ acre	810 M	Fungi	O. K.
Earp-Thomas	Agar	Cowpeas	¼ acre	13 M	Pure	O. K.
Earp-Thomas	Agar	Cowpeas	¼ acre	23 M	Foreign bacteria	O. K.
Earp-Thomas	Agar	Alsike	¼ acre	17 M	Pure	O. K.
Earp-Thomas	Agar	Alsike	¼ acre	121 M	Foreign bacteria	O. K.
Earp-Thomas	Agar	Red clover	¼ acre	125 M	Foreign bacteria	O. K.
Earp-Thomas	Agar	Red clover	¼ acre	15 M	Foreign bacteria	O. K.
Earp-Thomas	Agar	Red, white, alsike, berseem, mammoth and sapling clover	¼ acre	2,184 M	Pure	O. K.
Earp-Thomas	Agar	Alfalfa	¼ acre	Bottle cracked	—contents valueless	
Standard Inoculant Co.	Agar	Alfalfa	½ acre	65 M	Foreign bacteria	O. K.
Standard Inoculant Co.	Agar	Alfalfa and sweet clover	½ acre	90 M	Pure	O. K.
Standard Inoculant Co.	Agar	Alfalfa and sweet clover	½ acre	35 M	Pure	O. K.
Standard Inoculant Co.	Agar	Sweet clover	½ acre	817 M	Fungi	O. K.
Standard Inoculant Co.	Agar	Vetch	½ acre	61 M	Bacteria	O. K.
Standard Inoculant Co.	Agar	Vetch	½ acre	103 M	Fungi	O. K.
Standard Inoculant Co.	Agar	Cowpeas	½ acre	381 M	Pure	O. K.
Standard Inoculant Co.	Agar	Cowpeas	½ acre	124 M	Pure	O. K.
Standard Inoculant Co.	Agar	Red clover	½ acre	472 M	Pure	O. K.
Standard Inoculant Co.	Agar	Red, crimson alsike, white and mammoth clover	½ acre	3 M	Pure	O. K.
Standard Inoculant Co.	Agar	Red, crimson alsike, white and mammoth clover	½ acre	95 M	Pure	O. K.
Standard Inoculant Co.	Agar	Red, crimson alsike, white and mammoth clover	½ acre	95 M	Pure	O. K.
O. M. Scott	Sand	Red, crimson alsike, white and mammoth clover	30 lbs. seed	11 M	Fungi and bacteria	O. K.
O. M. Scott	Sand	Alfalfa and sweet clover	30 lbs. seed	300 M	Fungi	O. K.
O. M. Scott	Sand	Red, alsike, mammoth and crimson clover	30 lbs. seed	270 M	Fungi	O. K.
Western Soil Bact. Co.	Agar and Soil	Soybeans	1 acre	850 M	Pure	O. K.
Western Soil Bact. Co.	Agar and Soil	Cowpeas	1 acre	1,050 M	Pure	O. K.
Alphano Humus Co.	Peat	All crop	1 acre	38 M	Fungi	O. K. Red clover Alfalfa Cowpeas Garden bean Peas Weak Soybean Vetch

*M = million

REPORT OF THE DIVISION OF EXTENSION IN AGRICULTURE AND HOME ECONOMICS

Division of Extension in Agriculture and Home Economics

STAFF

Louis A. Clinton, M.Sc., Director.
Willard H. Allen, B.Sc., Specialist, Poultry Husbandry.
Mrs. Frank App, State Home Demonstration Leader.
Herbert R. Cox, M.S.A., Specialist, Soil Fertility and Agronomy.
Mrs. Catharine Griebel, Specialist, Sewing.
Elsie R. Horne, Assistant State Club Leader.
Arthur M. Hulbert, State Leader of Boys' and Girls' Club Work.
Ethel Jones, M.A., Asst. State Club Leader.
Mark H. Kenney, M.Sc., Specialist, Dairying.
William F. Knowles, A.B., Assistant State Leader of Farm Demonstration.
A. Freeman Mason, M.Sc., Specialist in Fruit Growing.
Ingrid C. Nelson, A.B., Assistant Editor.
Charles H. Nissley, B.Sc., Specialist Vegetable Growing.
Irving L. Owen, B.Sc., State Superintendent and State Leader of Farm Demonstration.
Florence Powdermaker, Ph.D., Specialist, Nutrition.
Stanley B. Roberts, Specialist, Dairying.
Carl R. Woodward, A.M., Editor.

COUNTY EXTENSION WORKERS

County Agents

County.
Atlantic—Arthur R. Eldred, B.Sc.
Bergen—W. Raymond Stone.
Burlington—Frank B. Cross, B.Sc.
Camden—Samuel F. Foster, B.Sc.
Cape May—James A. Stackhouse, B.Sc.
Cumberland—M. Robert Trimnell, B.Sc.
Essex—Irvin T. Francis, A.B.
Gloucester—Louis A. Cooley, B.Sc.
Mercer—William S. Barnhart, B.Sc.

County.
Middlesex—Orley G. Bowen, B.Sc.
Monmouth—Elwood Douglass.
Morris—Bertin E. Ely, B.Sc.
Ocean—Ernest H. Waite, B.Sc.
Passaic—Harold E. Wettyen, B.Sc.
Salem—John C. Crissey, B.Sc.
Somerset—Harry C. Haines.
Sussex—F. Leon Brown, B.Sc.
Warren—William A. Houston.

Home Demonstration Agents

Bergen County—Carolyn F. Wetzel.
Essex County—Eugenie B. Huckel.
Mercer County—Mrs. Edith R. Dilts, B.Sc.
Middlesex County—Frances Whitcomb, B.Sc.
Monmouth County—Helen G. Bishop, B.Sc.
Morris—Marian Butters, B.Sc.
Passaic County—Margaret H. Hartnett, B.Sc.
Sussex County—Marjory Eells, B.Sc.
City of Paterson—Mrs. Cecelia Brogan.

County Club Agents

County.
Burlington—C. A. Thompson, B.Sc.
Cumberland—Frank V. D. Cortelyou, B.Sc.
Mercer—Joseph B. Turpin, B.Sc.
Middlesex—Carl B. Bender, B.Sc.

County.
Monmouth—James A. Harter, B.Sc.
Morris—Harold S. Ward, B.Sc.
Ocean—Beatrice Farrell, B.Sc.
Salem—*S. T. Wheat, B.Sc.
Warren—Howard Mason, B.Sc.

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* On part time.

STAFF CHANGES

Resignations

Date	Employee	Title
Sept. 30, 1920	Elton R. Wagner	County Agricultural Agent, Cumberland County.
Oct. 9, 1920	Cora A. Hoffman	Home Demonstration Agent, Morris County.
Nov. 15, 1920	Harold J. Krause	County Club Agent, Monmouth County.
Jan. 31, 1921	Albert E. Wilkinson	County Agricultural Agent, Atlantic County.
Jan. 31, 1921	Lydia G. Salvador	County Club Agent, Ocean County.
Jan. 31, 1921	John W. Bartlett	Specialist in Dairy Husbandry.
Feb. 15, 1921	Joseph R. French	Assistant Specialist in Fruit Growing.
Mar. 5, 1921	Bessie G. Reece	County Club Agent, Ocean County.
Mar. 31, 1921	Ernest A. Howard	County Club Agent, Cumberland County.
June 30, 1921	Carolyn F. Wetzel	Home Demonstration Agent, Bergen County.
June 30, 1921	Maurice A. Blake	State Leader, County Agents.
June 30, 1921	Berten E. Ely	County Agricultural Agent, Morris County.

Appointments

Date	Employee	Title
Sept. 1, 1920	Florence Powdermaker	Specialist in Nutrition.
Oct. 1, 1920	M. Robert Trimnell	County Agricultural Agent, Cumberland County.
Jan. 1, 1921	Marian C. Butters	Home Demonstration Agent, Morris County.
Feb. 1, 1921	Margaret C. Becker	Home Demonstration Agent at Large.
Feb. 1, 1921	Bessie G. Reece	County Club Agent, Ocean County.
Feb. 14, 1921	Carl B. Bender	County Club Agent, Middlesex County.
Mar. 3, 1921	James A. Harter	County Club Agent, Monmouth County.
Mar. 8, 1921	Chas. A. Thompson	County Club Agent, Burlington County.
April 1, 1921	Willard H. Allen	Specialist in Poultry Husbandry.
April 11, 1921	Arthur R. Eldred	County Agricultural Agent, Atlantic County.
April 18, 1921	Mark H. Keeney	Specialist in Dairy Husbandry.
April 25, 1921	Frank V. D. Cortelyou	County Club Agent, Cumberland County.
May 3, 1921	Bertrice A. Farrall	County Club Agent, Ocean County.
June 6, 1921	Geo. E. Lamb	Assistant County Agent.

Transfers

April 1, 1921..Irving L. Owen became State County Agent Leader instead of Specialist in Poultry Husbandry.

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REPORT OF THE DIVISION OF EXTENSION

REPORT OF DIRECTOR

L. A. CLINTON

The work for the year has continued essentially along the lines of previous years. County agents have been continued in 18 counties of the state. Home demonstration agents have been employed in 8 counties and in the City of Paterson; county club agents have been employed in 8 counties; in club work 2 new counties were started, namely, Middlesex and Burlington. In both cases the counties cooperated in the employment of the agent. The policy of the Extension Service with reference to the development of home demonstration and club work is to develop this work only as fast as the counties become interested and provide appropriation for cooperation in the work. All of the cooperative extension work as conducted in the counties is financed from public funds. We believe that this method of financing the work puts it on a much sounder basis than it would by private or corporate contributions for the support of the work.

Cooperating Agencies

The Extension Service cooperates with the United States Department of Agriculture and with the various counties of the state in the support of extension work. While the county funds are appropriated by the Board of Freeholders, and their expenditure is under the supervision of the Extension Service, yet we recognize the County Board of Agriculture as being the organization which represents the county as a cooperating agency. The efficiency of extension work in any county is dependent upon a strong and active local cooperating organization. While work is done in cooperation with such organizations as the grange, farmers' clubs, public health service, and State Department of Agriculture, yet we have recognized in each county the County Board of Agriculture, and our plans for work have been made in cooperation with that organization.

Finances for the Work

The funds used in cooperative extension work are derived from appropriations by Congress under the Federal Smith-Lever Act, direct appropriations by Congress to the United States Department of Agriculture to be allotted to the various states by the States Relations Service, the state appropriation for farm demonstration work and appropriations by the various counties in support of the demonstration work within the county. Extension work is performed through the services of county agents, home demonstration agents, boys' and girls' club agents and by subject matter specialists who represent the Agricultural College and Experiment Station, and the United States Department of Agriculture. The subject matter specialists work with the county agents, carrying to them expert assistance in the development of plans for work, and in carrying out these plans.

The Program of Work

Extension work as originally conducted dealt largely with the immediate problems as they came up from day to day, and from week to week throughout the year. With the progress of the work, however, it has been found that if permanent and lasting work is to be done, this work is to be based on the development of a program designed to meet the agricultural problems as they exist in the various counties. This program of work must be based upon the development of a permanent, profitable and satisfactory agriculture in every county. In working out the program, the subject matter specialists from the college meet with the county agents and with special subject matter committees, and together they consider the needs of the county, plans by which the work may be conducted, cooperators and demonstrators selected, and when the plans have finally been arranged, they are the results of the cooperative effort of the specialists from the college and interested subject matter representatives from the counties and the county demonstration agents. This method of working out the program of work for every county has resulted in local interest and responsibility for the work not heretofore attained. Naturally, this plan has been carried out in some counties with greater success than in others, but we believe it is the right plan, and efforts will be made to bring about this method of procedure in every county.

Relations Within the College and Experiment Station

The subject matter specialists are considered as a part of the department with which they are associated, administratively responsible to the Extension Director, but responsible to the subject matter department for the instruction which is given. In all cases the specialists have office with the subject matter departments, take part in the department conferences, and are considered as being representatives of the department in their extension work. Through the active support which has been given by the heads and assistants in the various departments, extension work has been greatly strengthened.

County Agent Work

On April 1, Irving L. Owen became state superintendent of farm demonstration and state leader of county agent work succeeding Professor M. A. Blake, who has returned to his position as head of the horticultural department of the College and Experiment Station. Mr. Owen was formerly county agent of Middlesex County, and for the past year has served as extension specialist in poultry husbandry, and brings to the position of County Agent Leader an intimate knowledge of the State of New Jersey as well as a personal knowledge of the problems connected with county agent work. Eighteen of the 19 agricultural counties of the state are cooperating in the employment of county agents. During the year relatively few changes were made in the county agent staff. It is hoped that men engaged in county agent work may see possibilities in that work for a career, and that the turn-over may be much smaller in years to come than it has been in recent years. As the counties come to appreciate more and more the service rendered by county agents, there will be less disposition on the part of the counties to part with an agent, or to let him go somewhere else for a higher salary, but salaries will be adjusted, and the work will be so planned that the county agents will look upon their work as a permanent worthwhile occupation. The demonstration idea has been emphasized, and the major work of the agents is the giving of instruction through practical demonstrations of better methods of agriculture. In the conduct of these demonstrations, the farmers themselves take a large part of the responsibility, and only through this cooperation of farmers could success be secured.

Junior Demonstration or Boys' and Girls' Club Work

The work with the boys and girls has made a steady progress, and is considered one of the most fundamental lines of extension work. Upon the success of this work does the farm demonstration work and home demonstration work of the future largely depend. During the year most marked progress has been made in the developement of definite programs of work for the boys and girls. This work is developed along lines parallel to the farm demonstration work, the idea being that the work of the juniors should be in the demonstration of those practices which are considered good agriculture for the county. In this way the two lines of work strengthen each other. It seems necessary only to present the idea of what club work really means to a local community in order to secure the interest of that community. Men and women are interested in the boys and girls, and local adult leadership can always be found where the plans and purposes underlying club work have been properly presented. During the year an organization has been developed under which we hope to enroll those young men and women who have graduated from club work. Active club work is limited to those under 18 years. After this age has been reached, the club members have passed out from club work, and have not always been enlisted in the active program for extension work in the county. The purpose is to enlist the interest of these young people, and have them become not only local leaders for boys' and girls' clubs, but active in the promotion of cooperative extension work in all lines in their communities. The state-wide organization will enlist and enroll these young people and provide them with a program of work.

Home Demonstration Work

In the development of home demonstration work we are handicapped a bit by having no home economics departments in the college, but fortunately New Jersey is so close to home economics institutions that it is able to make use of those institutions as sources of subject matter material. A specialist in clothing and a specialist in nutrition have given most valuable aid to the home demonstration work during the year. In the organization of women's work committees in the counties, the work under this project has made marked progress. Women's work committees have not only given active support to the work of the home demonstration agent, but have through their membership actually assumed responsibility for the work in the county, supplementing the work of the agent, and thus making it possible to reach a larger number of homes. Some counties of the state are largely urban, and in these counties there has been more or less call for the service of the home demonstration agents in connection with urban work. In every county, however, it has been realized that cooperative extension work is primarily for rural people. It as been possible to so organize the work that urban and rural women have worked together, both helping in the development of the program, both taking a part in the actual conduct of demonstrations, and in the spread of influence. In no county where the work has been undertaken has request for local financial support for home demonstration work been refused.

Extension Work in Fruit Growing

While fruit demonstration work covers a wide range, it is possible that the work with paradichlorobenzene has been one of the outstanding features during the past year. In the control of peach borers, the old method of digging out the borer has been laborious and expensive. By the paradichlorobenzene treatment it has been found that almost perfect control may be secured. The demonstrations which have been held have carried to the fruit growers of the state detailed methods in the performance of this work. The field meetings which are held in the demonstration orchards have proved popular and instructive. The orchard demonstration work has been so outstanding in its results that the field meeting has been the means of convincing those present of the practical possibilities in the care of orchards, and the actual financial gain which may be secured through the care of these orchards. Owing to the serious damage done by the frost to the fruit crop of 1921, it is possible to stage certain demonstrations in orchard pruning and management preparatory to the expected crop of 1922. The equipment in the horticultural demonstration work has consisted of several power sprayers and an automobile truck for carrying the equipment. The fruit growers of the state are well organized in the State Horticultural Society, and this society has given valuable cooperation in the demonstration work.

Extension Work in Vegetable Gardening

The equipment for the vegetable gardening demonstration work has been added to during the year by the purchase of an auto-truck in which spraying outfit for use in the demonstration work can be carried to various parts of the state. This was found necessary if demonstrations in insect control were to be conducted. The importance of the vegetable interests of New Jersey has made demonstration work in this particular subject matter of very vital importance. Active cooperation has been furnished by interested vegetable growers, and through the use of the additional equipment for the work, most satisfactory progress has been made in this project.

Extension Work in Farm Crops and Soil Fertility

Success in all branches of agriculture is dependent upon the maintenance of soil fertility. This makes the work under this project most fundamental, and very closely related to the work of all other projects. With the high price of commercial fertilizer and with the impossiblility of purchasing stable manure in sufficient quantities, the matter of cover crops has assumed vastly greater importance. County agents and local committees have been given assistance in planning cover crop demonstrations in order to meet the principal needs of each county. While results from this work are not so apparent at the end of the season, yet through a series of years, it is believed that no phase of the demonstration work exceeds in importance that in connection with soil fertility.

Extension Work in Dairy Husbandry

The dairy business differs from most other lines of farm work in the fact that it is a permanent all the year round proposition. The cows must be cared for the entire year, and not only each day, but twice each day the cows must be milked. The close proximity of New Jersey dairy sections to centers of population makes the production of market milk the leading dairy industry. Through the support given to cow-testing associations, through special dairy schools, through the organization of bull associations, efforts have been made to improve dairy conditions. The great need in the dairy industry is better cows. The only practical way of securing better cows is to raise them, and this means that special attention must be given to the matter of pure-bred sires. Two specialists are devoting their entire time to the work in dairy extension. The members of the College and Experiment Station staff in dairying have been most active in their support of extension work.

Extension Work in Poultry Husbandry

During the year the poultry specialist became state leader of county agent work; his successor before coming here had been successfully engaged in poultry work in Connecticut. The poultrymen of New Jersey are probably more completely organized than the men of any agricultural group. Through the active support of the Poultry Association and through the help given by the members of the staff of the poultry department, the work in poultry extension has made steady progress. The culling of poultry improves the conditions of housing and feeding. Methods of control of poultry diseases have been leading features of the work. The rapid increase in importance of the poultry industry of the state as shown by the last federal census shows the wonderful adaptation of the state to the poultry business. Several specialists might be used to good advanage to do the work under this project.

Extension Work in Clothing

Probably no phase of home economics extension work has been more popular during the year than that in clothing and millinery. The opportunity which has been given to farm women to learn something of the principles of correct dress, and the adaptation of dress to the form has been eagerly taken advantage of. Women meet in groups, and leaders have been trained who have gone out and met and trained other groups. In this way the work of the specialist has been multiplied, and farm women have been interested in seeing that other farm women received the benefits from this work. A national conference of clothing workers was held at Ames, Iowa, during the year, and this conference resulted in special value to the work in New Jersey. The home demonstration agents and their supporting committees on women's work have given most active and valuable support to the work under this project.

Extension Work in Nutrition

We were fortunate in securing as leader for the work under this project a woman trained at Johns Hopkins University. While the work under most of the other projects largely deals with economic problems, the work in nutrition deals not only with economic problems, but deals vitally with health problems. As a result of surveys made in the schools, it has been found that large numbers of children are suffering from mal-nutrition. This is true where there is an abundance of food in the homes, and sufficient means to procure any food required. The trouble is due to lack of information as to the proper combination of foods for the proper nourishment of children. The leader of this project meets with groups of mothers, and discusses with them the matter of child feeding. Individual cases are considered, and as a result children who were formerly underweight have been brought up to standard size. Emphasis has been placed on the importance of milk as a food both for children and adults. It has been found that not only children in the cities sometimes suffer from lack of milk, but that children in the most important dairy sections of the state may also be suffering from lack of milk as a food. Addresses have been made, and demonstrations have been conducted at schools, at women's clubs, and the cooperation of teachers and parents has been secured for the furtherance of the work under this project.

Needs in Extension Work

For the proper development of extension work in order that it may meet more adequately the needs of the state, we should have funds sufficient for the employment of a specialist in rural engineering, a specialist in animal husbandry, and in the home economics side of the work, a specialist in home management. These specialists cannot be employed until we receive increase in funds or reduce our contribution towards the salaries of the county agents. In order to care for the natural growth of the work in the counties, we may expect within the next year call for cooperation in farm demonstration work in at least one more county, and cooperation in the support of home demonstration work in at least two counties, and in junior demonstration or boys' and girls' club work in two counties. To care for the work now under way, and provide funds for growth along these lines above mentioned would require an increase in our appropriation of not less than $10,000.

I wish to express my appreciation of the cordial support given to extension work by the Director of the Experiment Station, and members of the Experiment Station staff, by members of the college teaching force, and by various cooperating agencies at the college and within the state.

REPORT OF THE STATE LEADER OF COUNTY AGENTS

Irving L. Owen

Changes in County Agent Staff

During the period of this report there have been two resignations and two appointments in the county agent staff. The first occurred in Cumberland County, September 30, when Elton R. Wagner resigned and was succeeded on that date by M. Robert Trimnell. The second occurred in Atlantic County on January 30, 1921, when Albert E. Wilkinson resigned. He was succeeded by Arthur R. Eldred on April 11.

The plan inaugurated July 1, 1920, to employ two assistant county agents-at-large for the purpose of giving them training has proved to be a good one. During the year vacancies have been filled with men of at least one year's experience and training.

County Agent Conferences

Four regular and three special county agent conferences have been held during the season.

August Conference

Instead of conducting an extension tour for the purpose of making field studies at demonstrations, it was decided to hold a regular conference of county agents at the Experiment Station from August 9 to 11. The conference was unique in that the program was devoted almost entirely to subject matter training. Heads of departments and their assistants gave a period of intensive instruction which consisted of not only lectures, but visits to experimental plots where in most cases the agents had an opportunity of taking part in the work.

At this conference also each county agent was loaned a book entitled "The County Agent Guide," which had been compiled in the state leader's office. It is designed to furnish the county farm demonstration agents with condensed information as to the laws and regulations governing extension work; special facts and data relative to agricultural practices; progress of research at the Experiment Station and suggestions as to conducting various activities in connection with demonstration work. This Guide Book has been of great value to all the county agents. From time to time supplementary information is mailed to each county agent who places that information in the proper section.

October Conference

The annual fall conference was held at New Brunswick, October 21 to 23. Practically all the time of this conference was devoted to reports on the results of demonstration work for the season.

January Conference

The January conference was held at the College, January 26-28. At this conference the annual reports of the county agents were discussed. It was also announced that for the year 1921 quarterly reports would be expected from each county agent instead of monthly reports as heretofore. Some changes were also recommended in the weekly report blank so that information might be tabulated more carefully and consistently.

The state leader also presented a summary of special activities of all the county agents from December 1, 1918, to November 30, 1919.

March Conference

The regular March conference was held at New Brunswick on the seventeenth and eighteenth. At this conference a great deal of attention was given to the subject of county programs of work and their relation to quarterly reports. Agents were urged to follow their aims for the year when making out their quarterly reports so that not only could the state leader's office make out a better summary, but also in order that the county agents themselves might be able to furnish more definite facts at any time on the status of demonstration work.

Plans for the 1921 program of work in each county were presented and approved by the state leader.

April Conference

A special conference of county agents from seven southern counties was called at Glassboro on April 13. The purpose of this conference was to discuss the results of injury to the fruit crop because of the freeze of March 28 and 29.

The horticultural department staff was present and gave specific suggestions and recommendations as to pruning, spraying and cultural practices which the agents might recommend.

May Conference

A special conference of county agents and office clerks from the eight southern counties was held in the county agents' office in Woodbury on May 11. Some of the topics discussed were the "Opportunities of the Office Clerk," "Follow the Program of Work when making Reports," "The Wilson-Fuller Filing System," "Points to keep in mind when sending Monthly Financial Statements to the Director for Approval."

June Conference

A special conference of all the county agents was called at the College on June 17. At this time questions pertaining to the second quarterly report were discussed and arrangements were made for the annual fall conference.

Statistical Summary of County Agent Activities
July 1, 1920, to June 30, 1921

Table 1

COUNTY	Office Calls	Farm Visits	Demonstration Visits	Meetings at Demonstrations	Attendance	Other Meetings	Attendance	Letters Written
Atlantic	332	1354	397	17	234	187	3264	1919
Bergen	390	721	155	17	579	123	5102	1370
Burlington	623	626	144	23	366	63	4676	1547
Camden	572	776	255	16	213	22	516	950
Cape May	193	885	184	11	125	43	2390	1539
Cumberland ...	427	679	191	19	529	87	5392	1277
Essex	546	819	134	9	287	61	4215	1080
Gloucester	94	582	115	12	83	29	1337	1709
Mercer	369	1055	167	15	974	89	4104	715
Middlesex	317	566	179	3	57	50	2153	1729
Monmouth	1215	459	212	3	85	40	1882	2075
Morris	892	925	139	8	203	91	4260	998
Ocean	742	851	340	11	159	84	2337	1529
Passaic	1158	1076	262	16	406	78	1984	1509
Salem	885	1575	265	6	79	71	5841	1130
Somerset	690	533	50	16	225	69	1999	1063
Sussex	1040	748	99	9	151	98	8344	1826
Warren	1127	935	329	39	641	82	3705	2444
Total	11612	15165	3617	250	5396	1367	63501	26409

A Summary of Demonstrations

The type and character of demonstration work performed by the various county agents has been more carefully planned and classified for the year 1921 than in any previous year. Arrangements have also been made to check up the programs of work under project headings so that at any time the state leader may be able to furnish anyone specific information on the status of the aims in demonstration work in all the projects in any county. The activities for this season are nearly double the number for 1920. The following table indicates the type of work which is being conducted over the entire state:

Table 2

	Demonstrations	Practicums
ANIMAL INDUSTRY—		
Dairy	38	8
Poultry	141	135
Swine	6	
Sheep	1	4
FARM CROPS—		
Cereals and other crops	101	19
FORAGE CROPS—		
Alfalfa and Soybeans	34	7
ROOT AND TUBER CROPS—		
Sweet potatoes	98	13
Potatoes	143	6
Mangel beets	3	6
TRUCK CROPS—		
Vegetables	94	1
HORTICULTURE—		
Fruit Growing	124	109
SOILS—		
Cover crops and lime, etc.	75	
RURAL ECONOMICS—		
Farm Accounts	9	
Totals	867	302

The totals show 867 demonstrations and 302 practicums, making a total of 1169.

This is an increase over 1920 of 410 actual demonstrations and 60 practicums, making a combined total increase of 470 demonstrations. The list of demonstrations and practicums for the two years are compared below:

Year	*Demonstrations*	*Practicums*	*Totals*
1921	867	302	1169
1920	457	242	699
	410	60	470

Work of the Central Office

The state superintendent of farm demonstration and the assistant state superintendent of farm demonstration have spent considerable time in devising better weekly, quarterly and annual reports, and feel that the improvement made in this activity has been one of the outstanding features of their work. It is significant to note that the reports have greatly improved during the past year as a result of this effort.

The matter of uniform office and filing systems has also received particular attention and at the end of the period which this report covers, 10 farm demonstration offices have installed the Wilson-Fuller filing system. It is hoped that this system will be installed in the other 8 counties within a few months.

The central office has also endeavored to get every county agent to "plan his work and work his plan" as regards his demonstration work.

REPORT OF THE STATE LEADER OF HOME ECONOMICS

HELEN M. APP

To those interested in the development of home demonstration work in New Jersey, the recent formation of a state home bureau brings strong satisfaction, as it clearly shows that at last we are working with the women and not for them. A brief review of the events which have led up to the formation of this organization is perhaps advisable. The local women were of the opinion that home demonstration work had so developed that it would be impossible to get the best results without the support of an active organization. Farm demonstration work and home demonstration work are so closely connected that at the October meeting when the subject was discussed the best plan seemed to be to have the men and women in one organization on an equal basis.

The membership campaign of the fall and winter proved this impractical because of the high dues. This is emphasized by the fact that there are 364 women members in the Federation, while Passaic and Bergen Counties have a membership of 476 women in their county board of agriculture. Two meetings were held during the spring for discussing this matter and the decision was reached to form a home bureau with $1.00 membership fee which will be closely connected with the State Federation.

This organization will not in any way affect the relations of the Extension Department with the counties that are not members. The counties in the organization will be the ones that through their members can best determine how the work is functioning, can offer the best suggestions and can more easily determine what should be done in their counties. The work will be more rapidly developed under this plan because of the dual responsibility for the program. The projects that are now being developed will be discussed separately.

Organization Project

The development of the organization plans have been similar in all sections. New communities have been organized in every county. Local committees are formed which take the responsibility of the work in the county from the home demonstration agent. These communities in turn unite into districts for representation or send directly to the central committee a representative who will aid in forming the county program and take back to her communities the ideas and suggestions which she has received and which are of use to her women.

The training of local leaders has been one of the biggest accomplishments in this project during the past year. Before that time the home demonstration agent had assumed the responsibility of meeting the groups of women and giving them the help which they desired. The requests were so numerous that it was impossible for her to meet them all. After talking the matter over with the women's committee it was decided to select those women who were especially capable of handling the subject, give them special training and ask them to assist the home demonstration agent in meeting groups of women. This has been done in all organized counties and in 3 unorganized counties with the assistance of the specialist. Each county committee has assumed the responsibility of spreading the work in an unusually satisfactory way.

Sussex County began home demonstration work in July, 1920. Miss Marjory A. Eells was appointed home demonstration agent.

In October Miss Cora Hoffman resigned as home demonstration agent for Morris County and on January 1 Miss Marion Butters began work there.

Miss Margaret Becker was appointed as home demonstration agent-at-large on February 1. She spent the greater part of her time in Bergen County, preparatory to taking over the work in that county when the agent, Miss Wetzel, should resign on June 30.

In Atlantic County interest was aroused by the executive committee of the county board. An agent has been requested by the county, but no one as yet has been appointed.

Clothing Project

This work has been most popular. The specialist has worked out the fundamentals of clothing for the women in such a way that the help which they receive from the agents is something which will be of value to them in all their sewing. The same is true of the millinery. We are making hats and dresses, but at the same time are giving the help which will enable them to make all their clothing with greater care and better results. We consider the saving of time and nervous energy of so much value that the permanent patterns and dress forms have been given for this reason. In Bergen, Middlesex and Mercer Counties local leaders have assumed responsibility so well that they have held groups by themselves. In millinery the Bergen County leaders conducted all the groups in technique with such success that the same plans will be followed out the coming year. The table shows the accomplishment of the home demonstration agents in the clothing project of its different phases. There is no accurate way in which we could show the passing on of this work by one woman to another. We are confident, however (judging from the results that are known), that there are more women using the pattern or dress forms because of this passed-on information than the total number that the agents have directly reached.

PLATE 1.

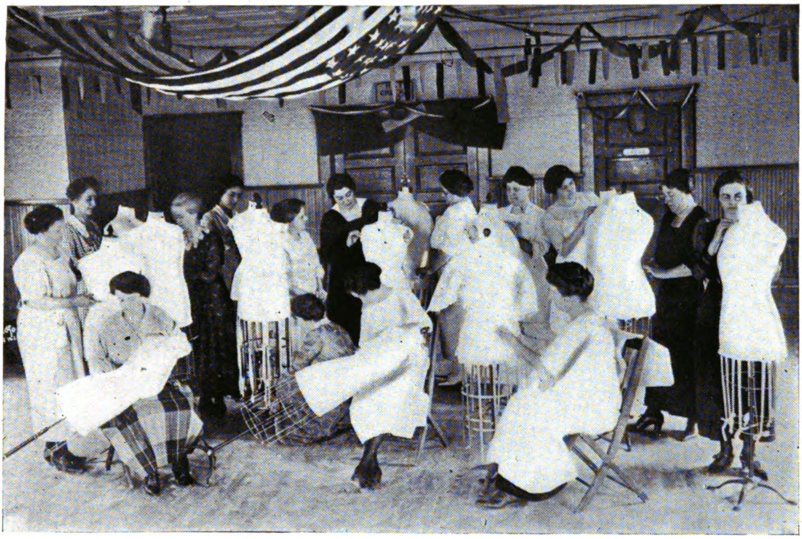

FIG. 1. A GROUP OF PASSAIC COUNTY WOMEN AT LAKEVIEW HEIGHTS ARE LEARNING TO MAKE DRESS FORMS UNDER THE INSTRUCTION OF THEIR HOME DEMONSTRATION AGENT, MISS MARGARET HARTNETT.

Through the assistance of leaders the specialist was able to carry on a large amount of work in the unorganized counties. A detailed report of the clothing work is given in the report of the specialist, Mrs. Catherine H. Griebel.

Clothing Statistics

NAME OF COUNTY	Permanent Pattern No. 1	Dress Forms		Millinery	
	No.	No.	Saving	No.	Saving
Bergen	302	153	$1,945.05	375	$2,182.21
Essex	95	25	290.99	98	617.42
Mercer	78	108	1,280.26	152	939.66
Middlesex	155	48	643.97	121	575.10
Monmouth	108	58	726.50	121	782.78
Morris	114	5	70.05	....	....
Passaic	278	64	792.12	137	828.43
Sussex	172	15	202.82	8	46.72
City of Paterson	127	5	72.08	139	715.10
Unorganized counties	118	27	337.50	7	48.05
Totals	1547	508	$6,361.34	1158	$6.735.47

Nutrition

The nutrition project was started in September, 1920, when Dr. Florence Powdermaker was appointed as specialist in nutrition. The war time need of food preparation has been forgotten. The information which the women desire on this subject is how to feed their families more easily and intelligently at a minimum of expense, but with a maximum of health and efficiency. Series of meetings which the specialist conducted with groups of women in Mercer and Essex County especially and those of the home demonstration agent in Morris County, are illustrations of the keen interest on the part of the women in these subjects. There will never be any way in which we can measure in money values the benefits of this work. Food habits are such personal matters that the women are reluctant to tell if they have made any changes because of the help which they received.

The school lunch work in connection with the weighing and measuring of the children by a public health nurse or other organization representative can show results along this line. Children that are 10 per cent underweight, with no serious physical defects have been brought up to standard by changing their food habits.

In connection with the Colonial Dames and the American Red Cross, Miss Mary Newell has been working with us since October on this phase of the work. She established a health center, under the direction of the home demonstration agent, Mrs. Brogan, at Paterson, and selected a group of children in the schools of Livingston and Roseland in Essex County for intensive work. In Perth Amboy a very successful demonstration was staged which the school authorities are anxious to continue the coming year. A detailed report of the project work is given in the specialist report.

Food preservation has not been stressed during the year. This information has been pretty well disseminated before. In order that we might find out just how much canning was being done, information was received from 240 women.

Food Preservation Record

	Quarts			
Fruits	26.626	Jellies, jams	16.778	glasses
Vegetables	18.901	Eggs preserved	3.571	doz.
Meats	1.639	Vegetables salted and brined	866	gallons
Fruit juices	1,391	Dried products	585	pounds
Pickles	3,704			

A study of these figures leads us to believe that the homes are preserving ample quantities of fruits and vegetables for winter consumption.

Home Management

This project is not developed as it should be because of a lack of a specialist. It is a fundamental phase of homemaking. Home-made fireless cookers as labor savers have been stressed in a few counties. Morris County is putting on an active campaign for household accounts which are to be used as a basis of determining food costs for that county.

Miscellaneous

Sussex County has stressed their poultry project. Four demonstrators were secured in different parts of the county who have been keeping accurate records of the cost of egg production from the farm yard flock. On the farms these flocks are, in the majority of cases, taken care of by the women. If we can interest the women in this work and make this small business a profitable one, it will be worth while undertaking. Some cooperative buying is being done; but we have learned from experience that it is wiser to do this buying through the cooperative organizations which were already organized in the counties. Essex and Morris Counties are following this plan.

PLATE 2.

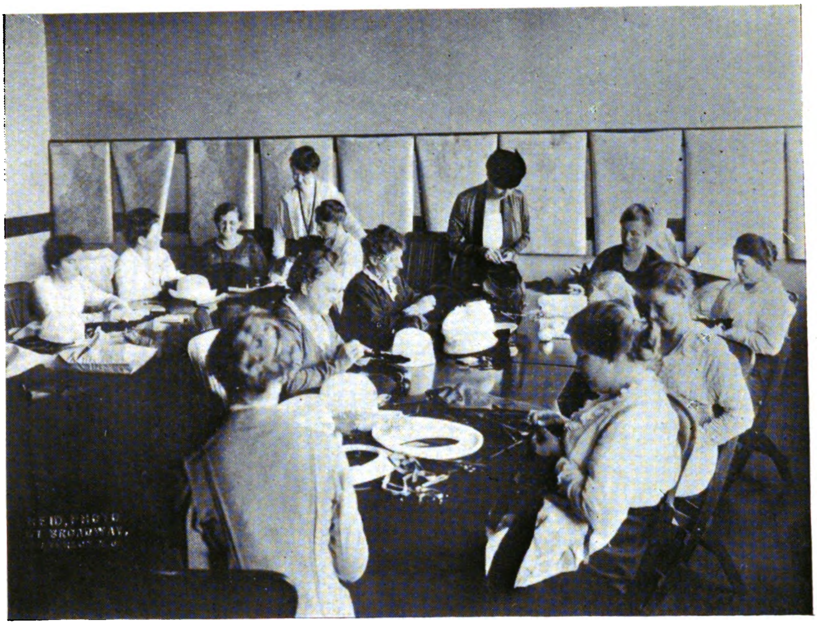

FIG. 2. PATERSON WOMEN LEARN MILLINERY SECRETS AIDED BY MRS. CECILIA BROGAN, HOME DEMONSTRATION AGENT, AND MRS. CATHERINE GRIEBEL, SEWING SPECIALIST.

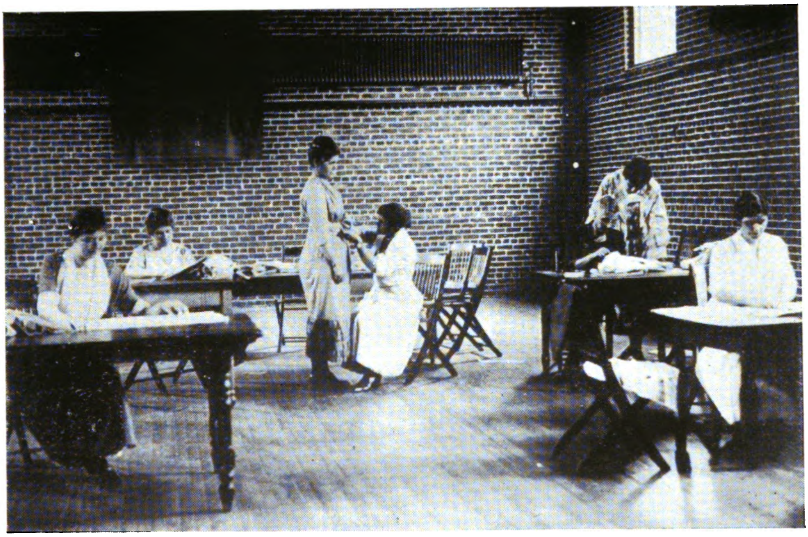

FIG. 3. FITTING THE PERMANENT PATTERN IN MIDDLESEX COUNTY.

Summary of Field Activities of Home Demonstration Agents

COUNTY	PROJECT WORK										
	Organization		Clothing		Nutrition		Home Management		Miscellaneous Home Visits		
	No.	Att.	No.	Att.	No.	Att.	No.	Att.	No.	Att.	No.
Bergen	40	1028	164	2359	28	671	8	125	3	18	43
Essex	32	521	106	948	42	1031	....	....	9	693	96
Mercer	13	408	95	863	6	140	6	99	5	115	79
Middlesex	40	1287	123	1177	31	682	15	265	7	74	32
Monmouth	34	953	124	1000	9	245	5	65	14	402	72
Morris	59	2868	55	537	38	611	11	203	17	303	238
Passaic	50	1032	156	2328	39	578	13	216	8	73	176
Sussex	16	484	87	851	36	1126	7	103	2	332	55
Paterson	20	570	146	1890	107	1862	14	171	....	....	93
Totals	304	9151	1056	11953	336	6946	79	1247	65	2010	884

Summary of Office Activities of Home Demonstration Agents

COUNTY	Office Calls	Telephone Calls	Letters	Circular Letters	Publications Distributed	Press Articles
Bergen	170	1168	1021	1936	767	7
Essex	183	628	719	1999	541	64
Mercer	22	488	811	834	127	70
Middlesex	78	545	1021	2700	658	24
Monmouth	138	378	562	5427	288	11
Morris	112	607	627	131	1437	46
Passaic	156	584	1359	1972	526	116
Sussex	120	257	937	599	298	29
Paterson	148	556	890	3835	969	106
Totals	1127	5211	7947	19433	5611	473

REPORT OF THE STATE CLUB LEADER

A. M. Hulbert

A summary of results in the various projects for the year ending December 1, 1920, as gathered from the reports of the county club agents at that time is given in table 1.

At the time of making our last annual report there were 5 county club agents employed cooperatively on full time basis. Since July 1, 1920, three additional counties have appointed club agents as follows:

County	*County Club Agent*	*Date Appointed*
Warren	Howard Mason	July 1, 1920
Middlesex	Carl B. Bender	February 14, 1921
Burlington	C. A. Thompson	March 12, 1921

Changes in the personnel of the club agents have taken place as follows:

County	*Agent*	*New Appointee*
Cumberland	E. A. Howard, resigned	F. V. D. Cortelyou.
Monmouth	H. J. Krause, resigned	J. A. Harter.
Ocean	Lydia Garnar Salvador, resigned	Bertrice A. Farrall.

The practice of employing part time county club agents has been discontinued in all counties except Salem. Here we have arranged with the vocational school at Salem and the county board of agriculture for the cooperative employment of Seth T. Wheat, whereby Mr. Wheat gives one-quarter of his time to the promotion and development of club work. The understanding in this county is that our present arrangement is temporary and looks foward to the time when a full time club agent will be employed.

Development of Policies

Theoretically Boys' and Girls' Club Work has always been regarded as one of the three coordinated pieces of extension work carried on within a county in cooperation with the county board of agriculture. It is only within the last year, however, that it has really come to take a place of equal rank and importance in the county organization and plan of work. We regard this as one of the chief elements of strength that has come to our work. It has given the county club agent a standing in his county and in the extension service which he has never before enjoyed and it has made it possible for him to work with the county organization in developing a program of work in a way which has never before been possible.

Table 1

CLUB DEMONSTRATION (Project)	Organized Clubs	Groups Finishing as Standard Clubs	Enrollment	Members Reporting	Value of Products	Total Costs	Total Value Above Costs
Corn	25	12	132	40	$1,330.75	$389.56	$941.19
Potato	10	....	90	30	1,057.55	427.00	630.55
Garden	71	30	1202	803	23,576.22	6,697.13	16,879.09
Pig (Pork Prod.)	26	14	160	97	3,476.48	2,253.54	1,222.94
Sow and Litter	1	....	22	13	2,260.00	666.29	1,593.71
Dairy Calf	5	2	84	43	9,254.75	4,021.24	5,233.51
Poultry	50	22	433	274	21,266.62	8,072.94	13,193.68
Canning	71	33	582	364	9,319.75	5,658.89	3,660.86
Bread	12	....	185	70	684.63	417.88	266.75
Cooking	7	11	88	42	535.95	281.29	254.66
Hot School Lunch	49	....	842	771	....	....	....
Clothing	58	23	593	330	4,872.07	1,948.98	2,923.09
Rabbit	2	....	34	14	387.25	53.25	334.00
Corn Testing	14	10	64	64	....	....	....
Sweet Potato	27	21	80	76	1,289.64	331.30	958.34
Home Making	28	....	704	704	2,335.00	817.00	1,518.00
Totals	456	178	5295	3735	$81,646.66	$32,036.29	$49,610.37

This brings us to the next thing which is an outgrowth of this better understanding, namely, the county club agent's program of work for the year. Never before have we been able to secure from county club agents definitely worked out plans of work for themselves. This year we have in our office a plan or program of work for each county which is the result of a study which the several club agents have made of conditions in their respective counties. These plans also give an index to the type of organization that is being worked out for each county, of the way in which the agent must divide his time, of his method of approach and the manner in which he makes his contracts.

The development of a more systematic ordering of the county club agent's activities through a plan of work has emphasized the importance of better office methods and of some means whereby the agent can keep a better check on his field activities. Consequently there has been established in each county a complete filing and recording system. The county agents are working out field books for their use by which they are enabled to keep a check not only on their own work but upon the progress that is being made in the various demonstrations and the work of the individual clubs.

By means of the statistical and narrative reports which come to the State Leader's office each month from the county club agents, it is an easy matter for the work of each county to be pretty definitely checked up. Through these reports it is easy for the State Leader and his assistants to follow the development of the organization within a county, to detect weaknesses that may exist and from this knowledge plan his visits and those of the Assistant State Leaders to the accomplishment of definite objects. All of which tends to the economy of time, effort and funds.

The Demonstration Idea

With the development of a better organization there has been given a more careful study of the real function of the whole field of extension service and particularly as that service is to be rendered through organized agricultural and home making clubs. It has been found that in principle there is no difference between adult and junior work; that the primary idea of both is to carry on demonstrations in agriculture and home economics with the thought in mind of affecting the farm and home practices of the people of the community in which the demonstration is carried on. The universal acceptance of this principle by the club agents has changed to a marked degree their methods of making contracts and of organizing clubs. Each enterprise that is undertaken is planned for the purpose of attacking some phase of a community problem either of the farm or the home. Clubs are no longer organized at random or with a vague or uncertain purpose. The following story taken from the April narrative report of J. B. Turpin, County Club Agent of Mercer County, is an illustration of methods that are coming into common practice in the state:

"Perhaps the most important and successful accomplishment in Boys' and Girls' Club Work in Mercer County to date is the work which has been done in Pleasant Valley, a community in the northwestern part of Mercer County. The most significant fact about this work has been the short period of time which has elapsed since it was first started. A brief history follows: The county club agent got in touch with William H. Blackwell, a member of the Executive Committee of the County Board of Agriculture, living just beyond the boundaries of Pleasant Valley, but a man who is well acquainted with every farmer in the Valley. In the latter part of March Mr. Blackwell and the club agent visited Howard Hunter, a young farmer living in the Valley. Mr. Hunter agreed to look after the boys who would join the various projects which might be carried on. After this visit it appeared that there was some interest in calf club work, although this was very slight. The Club Agent first met a small group of boys and discussed the matter with them. It was evident that we would not get far in this way, and accordingly the plans were made with Mr. Hunter and Mr. Hill, a member of the Calf Club Committee of the Mercer County Holstein-Friesian Breeders' Association, to visit individual farmers. This was done in the latter part of March and not a farmer was missed.

"As a result of this day's trip it was found that enough of the men visited were interested to warrant our trying to locate some calves. In the early part of April, Mr. Bartlett, Mr. Hill and the County Agent visited the Rancocas farms in Burlington County and located some animals. At this time it was supposed that none of the parents would be willing for their boys to have calves which would be priced higher than $50 or $55.

"A community meeting was called in the school house. Mr. Hill outlined the result of our search for calves, and it was found, much to our surprise, that most of the men were willing to invest more money and get better stock than that which we had located. The county club agent agreed to try to find 8 or 10 calves within 10 days.

"Before the meeting adjourned the farmers decided that they would like to see the animals before they were purchased and asked if a trip might not be planned for that purpose. Accordingly the county club agent got in touch with Mr. Van Nuys, secretary of the Hunterdon-Somerset County Holstein-Friesian Association, who agreed to act as guide through Somerset County when the trip came off. On Monday, April 25, a dozen or more farmers and their older boys started in three cars from Pleasant Valley. We proceeded to Belle Meade where we were met by Mr. Van Nuys. With Mr Van Nuys as guide we visited 7 herds in Somerset County. After this trip we went to Burlington County to the Rancocas stock farms. Owing to tire trouble, we did not get back to the vicinity of Trenton before 8 or 8:30 P. M. The entire party went to the home of L. W. Hill where the men discussed the day's trip and decided to purchase for their boys and girls a total of 11 animals including 2 pure-bred bull calves. All of the animals which were secured were of good breeding.

"The following is the list:

2 six-months old heifer calves	$200
1 five-months old heifer calf	80
1 young bull calf	50
1 four-months old bull calf	40
1 heifer calf	55
1 heifer calf	100
1 heifer calf	75
1 heifer calf	80
1 young calf	25
1 guernsey heifer calf	125
1 heifer calf	75

"The total purchases for the day's trip were $780. The pure-bred guernsey was purchased later. This brought the total paid for pure-bred animals for this trip $905. As a further result one of the boys expects to get a pure-bred calf within two or three weeks and one of the other boys a pure-bred calf which will be introduced into the community a little later, by a parent of one of the boys. The importance of this project can only be surmised after having made a trip of inspection through the herds. Prior to their arrival there was but one pure-bred calf in the valley and this was not very desirable.

"All of the animals which were purchased have arrived with the exception of one. On Wednesday evening, May 3, notwithstanding the fact that the night was exceedingly stormy the majority of the parents and boys were out to the schoolhouse planning with the club leader and Mr. Hill the program of work. It was decided that one of the big features of the club will be a local exhibit which will be held in August. The club wants to make this exhibit one of the best exhibits which has ever been held in the state. The other club projects will be represented and Mrs. Dilts, Home Demonstration Agent and the farm women are planning to have a Home Demonstration Exhibit at the same time."

Specialist

Having established what the work of the junior extension service is it became less difficult to see the relation of the specialist to it. Just as the adult extension work must depend largely upon the help of the subject matter specialist for direction along subject matter lines, so is the junior worker dependent upon him. We feel that the two are the same in kind. The boy with his poultry flock or the girl with her food or clothing problem needs exactly the same advice as the man or woman would need with a corresponding problem. With the juniors it is simply a question of adaptation and scope.

We are pleased to state that our agents as well as the specialists see this relation and are making their practices conform to this somewhat new idea.

Local Leadership

The question of local leadership has been one which has caused much difference in opinion in the past as to its practicability. There has been much division of sentiment as to whether volunteer local leaders can be found or not. We feel that this question has been answered by the work which the county club agents have done during the last 6 months from January 1 to June 30. One agent reports 20 clubs organized and 20 leaders; another 24 clubs and 21 leaders with 4 assistant leaders; another 20 clubs and 20 leaders; another 21 clubs and 21 leaders. These represent an average for the state.

Another question related to that of the local leader is of local leader conferences, or training schools. We feeel that this also has been answered and that our club agents have found the answer. Several most successful conferences of local leaders have been held during the past year and this has established beyond a doubt, not only that such conferences can, but that they should be held. The most successful meeting of this kind, perhaps, was held at Madison in Morris County. This was an all-day meeting attended by about fifty older club members and twenty-five local leaders. The program was so arranged as to provide for both the older and the younger persons present to have a definite part in making it a success. It proved the value of such meetings.

Reaching the Rural Community

The total enrollment for the state on June 30, 1921, is somewhat below what it was a year ago. This is due to three main causes. First, there has been a decided change in policy regarding the type of work that is being done in the dairy, swine and poultry demonstrations. In the dairy and swine work emphasis is laid on stock improvement by the introduction of pure-bred animals for breeding purposes rather than having boys raise an animal with no definite aim toward which he is working.

We have discouraged the hatching and rearing of chickens and are conducting our work in all counties as a demonstration in poultry management, having the junior demonstrator begin with the farm flock or a flock of pure-bred birds just coming to maturity, or ready to give returns for effort.

In all of these demonstrations we are recommending that the work start in the fall, and we are looking forward to substantial increase in enrollment during the next four months.

The second cause for falling off of numbers is due somewhat to loss of interest in the small garden in the back yard of the town and city home, also to the decreased amount of stimulation that is given to food production and conservation as compared to the previous three or four years.

The third and largest contributing factor, however, is the fact that our county club agents have come to understand that their work is with the rural people in the more sparsely populated communities, and not in the cities and towns where in many instances the club agents have been working.

A quotation from the monthly report of H. S. Ward, County Club Agents of Morris County, is suggestive of how these contacts are being made and of the amount of effort that really has to be made before any definite results can be recorded. It follows:

"In accordance with a wish of the County Board of Agriculture that the three agents extend their work out to the rural districts of the county as quickly as possible, some time was spent getting acquainted and arranging and holding meetings in our rural districts.

"Wednesday, June 8, was spent in a tour of the northeastern section of the county, with the home demonstration agent. After going through Butler, Newfoundland and other places, it was finally decided to make a contact at Milton, where we arranged for a community meeting to be held on the night of June 24. At this meeting we had Mr. Haines, of the County Board, present. The work of the office was explained, and contact made afterwards with one boy who promises to be a leader in club work.

"Another successful community meeting was held at Ironia, on the night of the twenty-third. Fred Bryant and family had their neighbors come in and sit around on the porch and lawn. The three agents explained their work. I am not so sure that club work will be possible there, but other branches of extension work are already started.

"All day on June 28 the three agents toured the northwestern part of the county, going through Mt. Olive, Draketown and other places. The contact that I made at Draketown looks as though a livestock club might be started.

"The three agents now feel that they have a good understanding of the lay of the roads in Morris County, and that they will be able to extend their work to a larger number of rural people."

ANNUAL REPORT EXTENSION SPECIALIST IN VEGETABLE GARDENING

C. H. NISSLEY

The following report covers vegetable extension work from July 1, 1920, to July 1, 1921. Part one includes the results of demonstrations completed. Part two is a statement of work under way at the time of writing this report.

Part I

The following vegetable projects were the ones emphasized:

- Vegetable Project No. 1 —Canhouse Tomatoes.
  - Sub-Project No. 1-a—Varieties.
  - Sub-Project No. 1-b—Use of better plants.
  - Sub-Project No. 1-c—Proper use of commercial fertilizer.
  - Sub-Project No. 1-d—Spraying for insects and disease control.
  - Sub-Project No. 1-e—Home selection and saving of seed.
  - Sub-Project No. 1-f—Cover crops.

- Vegetable Project No. 2 —Market Tomatoes.
  - Sub-Project No. 2-a—Fertilizer demonstrations.
  - Sub-Project No. 2-b—Blocking.
  - Sub-Project No. 2-c—Home seed saving.

- Vegetable Project No. 3 —Sweet Potato Demonstration.
  - Sub-Project No. 3-a—Variety.
  - Sub-Project No. 3-b—Fertilizer.

- Vegetable Project No. 4 —Pepper Demonstration.
  - Sub-Project No. 4-a—Fertilizer.
  - Sub-Project No. 4-b—Selection and home saving of seed.

- Vegetable Project No. 5 —Sweet Corn Demonstration.
  - Sub-Project No. 5-a—Improvement of sweet corn by ear and row method.

- Vegetable Project No. 6 —Celery Demonstration.
  - Sub-Project No. 6-a—Control of the late blight.

- Vegetable Project No. 7 —Horse-radish Demonstration.
  - Sub-Project No. 7-a—Fertilizer.

- Vegetable Project No. 8 —Seedbed Sterilization.

Vegetable Project No. 1—Canhouse Tomatoes

As the result of a conference in Wilmington, Delaware, last February, between representatives of the canhouse tomato growers, the Experiment Stations and canners of the Tri-State territory, the vegetable specialist was placed on a committee to take charge of New Jersey in the demonstration and propaganda work in reference to the growing of this crop. Recommendations were written and mimeographed, and sent out to the county agents, to canners of the state and to interested growers. In outlining this project, it was decided that one demonstration in each county, making this demonstration county-wide, would be sufficient, this project to include all of the best known practices which could be secured through experimental and practical experiences.

Varieties

The varieties used in these demonstrations were the Bonny Best for the second early and the Greater Baltimore for the late. These varieties have given the best results under existing conditions. The seeds used on all of the demonstrations came from a common source and were distributed by the vegetable specialist to the demonstrator. Through experimental work and previous demonstration work it has been proved that plants play a great part in the total production of fruit. Therefore, it was a requirement that every demonstrator start the seed in the hotbed and transplant his plants in cold frames so as to have good size plants to set into the field before the fifth of June. This was not followed out in all counties, especially the most southern counties, due to the cold and wet weather early in the spring. These men do not have sash, but plant their seed in the open garden without any protection whatsoever from cold or rain. Under these conditions, the plants in Cumberland and Salem Counties were not transplanted.

Fertilizer

The fertilizers used on the demonstration acre varied considerably, owing to the previous crops and method of farming. The fertilizers used on the various demonstrations were entirely in accordance with the recommendations from the specialist. The spraying work was started in June. In the southern counties, 6 applications were made at intervals of 10 to 12 days, this being in accordance with the recommendations from the Department of Plant Pathology. Where insects were present, either Black Leaf "40" or an arsenical was used to combat the insect.

Seed Selection

A campaign was carried on in Cumberland County particularly in reference to the home selection and saving of tomato seed. The county agent and vegetable specialist spent 6 days covering 30 farms which represented over 250 acres of tomatoes. The tomato fields were rogued on these farms, and when possible individual plants were staked from which the entire fruit was to be saved for seed. In a few cases after going over the entire field of from 8 to 10 acres, the specialist was unable to find even one plant from which to save seed, which clearly shows that good seed is necessary for a good crop, and proves that much constuctive work can be done along this line. On the farm of John Middleton in Sussex County enough plants were staked to secure from 8 to 10 pounds of seed. Mr. Middleton has been selecting his tomato seed for the last 8 to 10 years by plant selection, and has developed one of the finest strains of Bonny Best in the state. This seed will be used next year for distribution throughout the southern counties, and will be used in Boys' and Girls' Club work throughout the state.

Assistance was given H. F. Hall of the Joseph Campbell Company of Camden in going over tomato fields in Burlington and Camden Counties, which were to be saved for seed purposes. A corps of efficient inspectors were already doing good work, and the type of tomato selected was of the highest which could be expected in mass selection. The specialist was able to watch the tomatoes come into the factory where double inspection was made, and also to follow up the process of seed extraction, washing and the drying process. All of this work has been aimed towards one thing, and that is to eliminate the use of cannery run seed.

Tomato Seed Saving

Demonstrations were conducted throughout various communities in North Jersey counties on the selection and saving of seed. These demonstrations were given at public meetings either on the demonstration plot or on county tours.

In Bergen County one demonstration was given at the annual summer tour, at which there were 40 present. Individual fields were rogued for growers and plants staked merely to familiarize the individual grower with the methods recommended.

Following are individual reports from the various canhouse tomato demonstrations:

Demonstrator: Aubry S. Walton, Moorestown, N. J.

County: Burlington.
Variety: Bonny Best.
Seed: Stock seed furnished by the vegetable specialist.
Fertilizer: Home-mixed, 4-8-4. Application 600 lbs. per acre in row.

Cultivations: Six thorough.
Application of Nitrate of Soda: Side dressed June 29, 49 lbs.
Application of Sulfate of Ammonia: Side dressed June 29, 30 lbs.

		gallons bordeaux mixture and black leaf "40"
Sprayings:	June 29	12
	July 13	25
	July 26	50
	Aug. 7	36
	Aug. 18	40

Insects present: Plant lice were quite prevalent on second spraying, at which time black leaf "40" was added to the solution and controlled. The Colorado potato bug was extremely bad the latter part of the season, eating both foliage and fruit.

Diseases present: The diseases present on the demonstration were the leaf spot and "streak," the latter causing very much damage to the unsprayed portions of the fields. Spraying of the vines retarded to a great extent the spreading of the disease, and kept the vines in a green condition longer in the fall so as to mature the crop formed.

Yields:

	tons per acre
Sprayed block	12.36
Unsprayed block	7.44
Nitrate of Soda block	7.0
Sulfate of Ammonia block	5.6

NOTE.—On August 25 a meeting was called on the demonstration plot, at which time 22 interested growers were present. After the meeting on this plot, another meeting was held on the experimental plots nearby, conducted by the vegetable department of the State College of Agriculture.

Demonstrator: William H. Garwood, Merchantville, New Jersey.

County: Camden.
Variety: Greater Baltimore.
Seed: Stock seed furnished by the specialist.
Fertilizer: Commercial 4-8-4. 400 lbs. per acre in row, 400 lbs. broadcast.
Cultivations: Six.
Application of Nitrate of Soda: June 1, 200 lbs. broadcasted over entire acre.

		gallons bordeaux mixture and calcium arsenite
Sprayings:	June 29	36
	July 12	60
	July 23	60
	Aug. 5	36
	Aug. 17	25

Insects present: Few plant lice and potato beetles present, but after first sprayng disappeared.

Diseases present: Leaf spot and "streak" developed later in the season, but not seriously. Few plants showing fusarium wilt appeared scattered through the field.

Yields per acre:

	tons per acre
Sprayed block	17.48
Unsprayed block	14.75

NOTE.—On August 27 a field meeting was held on the demonstration plot, at which 35 growers were present. Very much interest was shown at this meeting, at which the vegetable specialist gave a talk on the home selection and saving of tomato seed together with fundamental principles involved in the growing of the crop. An inspection of the acre was of interest to all of those present.

Demonstrator: Ellis Thompson, Dias Creek, New Jersey.

County: Cape May.
Variety: Bonny Best.
Seed: Stock seed furnished by specialist.
Fertilizer: 3-8-3 commercial. 600 pounds per acre in row.
Cultivations: Six.
Application of Nitrate of Soda: July 7, 1920. 50 pounds side dressed.
Application of Sulfate of Ammonia: July 7, 1920. 36 pounds side dressed.

		gallons bordeaux mixture and black leaf "40"
Sprayings:	June 24	12
	July 7	50
	July 19	50
	July 31	50
	Aug. 13	50
	Aug. 25	50

Insects present:

Diseases present: Bad infestation of leaf spot and tomato "streak" on the unsprayed plots. The sprayed area and areas receiving the dressing of nitrate of soda and sulfate of ammonia did not show as much infestation.

Yields:

	tons per acre
Sprayed block	7.35
Unsprayed block	4.46
Nitrate of soda block	5.53
Sulfate of ammonia block	4.82

NOTE.—Twenty-seven plants on the sprayed block and from the selected seed were saved for seed purposes. Mr. Thompson helped to make the selection of the plants after it was explained to him, and was very enthusiastic in looking for the different points, especially on the structure of the tomato itself. Mr. Thompson will carry this work on next year, and will also try out the selected seed against commercial seed which is commonly purchased in the neighborhood.

Demonstrator: Leslie A. Platts, Bridgeton, New Jersey.

County: Cumberland.
Variety: Greater Baltimore.
Seed: Stock seed furnished by the vegetable specialist.
Fertilizer: 3-8-3 commercial. 650 pounds per acre in the row.
Cultivations: Five thorough. Two middles.
Application of Nitrate of Soda: Side dressed July 20, 1920. 33 pounds.
Application of Sulfate of Ammonia: Side dressed July 20, 1920. 24 pounds.

		gallons bordeaux mixture
Sprayings:	June 25	12
	July 8	20
	July 20	25
	Aug. 2	36
	Aug. 14	36
	Aug. 26	36

Insects present: Slight infestation of plant lice and potato beetles but not serious.

Diseases present: Indications of mosaic, tomato "streak" was very much in prominence.

Yields:

	tons per acre
Sprayed block	5.05
Unsprayed block	5.91
Nitrate of Soda block	5.6
Sulfate of Ammonia block	5.1

NOTE.—Owing to poor plants, Mr. Platts was not able to plant into the field until the eighteenth of June, after which time weather conditions were so that the plants did not grow rapidly and consequently the yields on this plot was quite low. In order that these men in Cumberland County could grow a larger tonnage of canhouse tomatoes, it was necessary for them to start their plants earlier and transplant them before they were set into the field; this takes place not later than June 5.

Demonstrator: A. H. Forsythe, Sewell, New Jersey.

County: Gloucester.
Variety: Bonny Best.
Seed: Stock seed furnished by the vegetable specialist.
Fertilizer: 4-8-4 commercial. 1000 pounds per acre in rows.
Cultivations: Four cultivations.
Application of Nitrate of Soda: Side dressed July 22. 32 pounds.
Application of Sulfate of Ammonia: Side dressed July 22. 23 pounds.

		gallons bordeaux mixture
Sprayings:	June 28	12
	July 10	These sprayings were put on by Mr. Forsythe and County Agent Cooley with a two-horse power sprayer. Standard bordeaux mixture was used.
	July 21	
	Aug. 3	
	Aug. 13	
	Aug. 26	

Insects present: Heavy infestation of potato bugs caused much damage to young plants. Plant lice not so numerous, however, present and doing damage to plant growth.

Diseases present: The tomato "streak" disease was quite bad and caused a great decrease in yield, especially on plots not sprayed.

Yields per acre:

	tons per acre
Sprayed block	4.9
Unsprayed block	2.1
Nitrate of Soda block	5.8
Sulfate of Ammonia block	4.68
Check: 500 pounds (5-10-0 fertilizer)	3.09
Check: 500 pounds (4-8-4 fertilizer)	2.67

NOTE.—The results of this demonstration are not representative, due to the fact that after the county agent and the demonstrator had transplanted them into the cold-frame, the plants were watered very heavily late in the evening and the sash placed on tight. As a result 95 per cent of the plants damped off. Hot-bed seedlings were secured from the Joseph Campbell Co., and transplanted into the same bed, but they did not make the growth which they should have, and were quite small when set into the field.

Demonstrator: Fernando Blackwell, Pennington, New Jersey.

County: Mercer.
Variety: Bonny Best.
Seed: Stock seed furnished by the vegetable specialist.
Fertilizer: Manure 10 tons. Commercial 4-8-4 fertilizer, 600 pounds in rows.
Cultivations: Five thorough.
Application of Nitrate of Soda: Broadcasted July 30. 25 pounds.
Application of Sulfate of Ammonia: Broadcasted July 3. 16 pounds.
Sprayings: June 30....12 gallons standard bordeaux and arsenate of lead
July 15....25 gallons standard bordeaux and black leaf "40"
July 28....40 gallons standard bordeaux and black leaf "40"
Aug. 9....30 gallons standard bordeaux
Aug. 20....30 gallons standard bordeaux

Insects present: Potato bugs present at first spraying, and plant lice on next two sprayings.

Diseases present: Leaf spot quite in prominence, with tomato "streak" doing much damage later in the season.

Yields:

	tons per acre
Sprayed block	8.32
Unsprayed block	5.78
Nitrate of Soda block	6.65
Sulfate of Ammonia block	8.54

NOTE.—The plants used in this demonstration were secured from the Joseph Campbell Company and were spotted plants. This demonstration showed up clearly that the local growers in raising their plants did not start the seed early enough to produce a full crop. A demonstration was held on this plot on August 26, at which time 19 men were present.

Demonstrator: Lester S. Harris, Hancock's Bridge, New Jersey.

County: Salem.
Variety: Greater Baltimore.
Seed: Stock seed furnished by the vegetable specialist.
Fertilizer: Manure at rate of 10 tons per acre.
600 pounds per acre of a 3-8-3 commercial.
800 pounds per acre of acid phosphate.
600 pounds per acre of acid phosphate.
Cultivations: Five thorough.
Application of Nitrate of Soda: Side dressed July 21. 23 pounds.
Application of Sulfate of Ammonia: Side dressed July 21. 16 pounds.

		gallons bordeaux mixture
Sprayings:	June 26	12
	July 9	20
	July 21	32
	Aug. 3	36
	Aug. 16	38
	Aug. 27	30

Insects present: Slight infestation of plant lice.
Diseases present: Slight infestation of tomato "streak."

Yields:

	tons per acre ripe	*tons per acre green*
Sprayed block	9.15	3.67
Unsprayed block	12.08	.50
Nitrate of Soda block	11.84	1.53
Sulfate of Ammonia block	11.84	2.13
600 pounds Acid Phosphate	16.78	1.6
800 pounds Acid Phosphate	16.67	1.84

NOTE.—Two demonstration meetings were held on this plot. The first on August 21, at which 36 interested men were present. The second meeting was held on September 4, at which time 14 men were present. On this demonstration the acid phosphate gave much heavier yields due to the fact that the soil was more or less heavy, and had had very heavy applications of manure alone.

Vegetable Project No. 2—Market Tomatoes

The blocking of early plants in the cold frame continues to be an important and interesting demonstration. In every case where the demonstration was carried on the tomatoes on the blocked plants ripened from 2 to 3 weeks earlier than on the unblocked plants, and this year the difference was even greater. As the result of this work during the last 2 years, the majority of the growers in Bergen County are blocking their plants. Growers in other counties are following the system, and it is greatly appreciated. On the farm of Calvin Lawrence near Dover, a field meeting was held on the demonstration block. About 38 interested growers were present, at which time circulars were distributed describing the blocking system, as well as the home selection and saving of tomato seed. On the demonstration block there were 7 plants staked for seed purposes, the fruit of which was all saved for seed. Those present were able to examine the staked plants and follow out instructions. The result of these demonstrations is probably best told by the demonstrators themselves.

The following letters were received by 2 of the demonstrators who had practiced the blocking of early tomato plants:

"We had begun to think that nearly all the tricks in producing the earliest tomatoes were known until the blocking system for plants was explained to us a few years ago.

"The picture will show the difference between blocked and unblocked plants. The blocked plants are at least 3 times the size of the unblocked ones and are loaded with fruit while the others have set but a few tomatoes.

"The plants are exactly the same age. The large ones to the right were transplanted twice and blocked, while the small plants were transplanted but once and dug with a fork.

Table 1
TOMATO VARIETY DEMONSTRATION
By C. L. LAWRENCE
Tomatoes Set to Field—May 25, 1920

Variety and Number of Plants	*Blocked or Unblocked*	*Date First Tomatoes Sold and Selling Price Per Basket*	*Total Yield (Baskets)*	*Total Selling Price*	*Remarks*
Earliana (1000)	Blocked	July 23 @ $2.50	197	$205.15	Many lost by sun scald
Earliana (350)	Unblocked	Aug. 10 @ $1.50	40	$27.75	Yield reduced by sun scald
(1000)			(114)	(79.40)	
		Variety Demonstration			
John Baer (1400)	Unblocked	Aug. 12 @ $1.25	399	$200.25	
Chalk's Early Jewel (280)	Unblocked	Aug. 17 @ $0.50	71	$35.00	
Bonny Best (280)	Unblocked	Aug. 19 @ $0 50	78	$39.00	
I. X. L. (280)	Unblocked	Aug. 19 @ $0 50	47	$23.50	Many ill shaped and unsalable
New Glory (280)	Unblocked	Aug. 20 @ $0.50	27	$13 50	Many ill shaped and much rot

Total receipts from 3,870 plants.................................$544.65

"Plants were all set in the field at the same time and received the same treatment, and there was no intention of making a comparison. Both sets of plants had blossoms on when transplanted, and while the unblocked plants wilted badly and dropped their blossoms, the other plants grew right along as if they had never been moved and began ripening their fruit more than 2 weeks ahead.

"We also find that the yield of the block plants as in nearly every instance been more than double that of the unblocked ones. The results obtained for the past 3 years are in my opinion easily explained. Any gardener at all familiar with the business will readily understand that a plant with a chunk of dirt 5 inches square filled with a mass of fine hair roots ready to go to work as soon as set in the field will easily out-grow and out-yield a plant that has been dug or pulled out with but a few roots and which is compelled to begin life all over again before it can get down to its life task of producing fruit.

Table 2

Fertilizer	Yield per Acre In Tons	Yield per Acre In Crates	Cost of Fert. Per Ton	Cost of 800 lbs. of Fert.	Fertilizer Cost Per Crate	Value of Crop at $.50 per Crate	Profit Over Fertilizer
J. P. Zabriskie Plots							
5-8-0	8.602	521	$58.40	$23.36	$0.0448	$260.50	$237.14
4-8-4	8.792	533	61.00	24.40	0.0458	266.50	242.10
4-10-0	9.5	576	56.00	22.40	0.0388	288.00	265.60
Acid Phos. ...	7.5	545	24.75	9.90	0.0218	227.00	217.10
7-10-0	10.753	652	43.75	17.50	0.0268	326.00	308.50
4-8-5	8.751	530	62.00	24.80	0.0468	265.00	240.20
Chas. Breisacher Plots							
5-8-0	19.217	1134	$58.40	$23.36	$0.0206	$567.00	$543.64
4-8-4	19.871	1204	61.00	24.40	0.0203	602.00	577.60
4-10-0	18.605	1128	56.00	22.40	0.0199	564.00	541.60
Acid Phos. ...	15.515	940	24.75	9.90	0.0105	470.00	460.10
5-8-4	19.95	1209	65.90	26.36	0.0318	604.50	578.14

"I am sending you a report of the tomato demonstration on my farm this year with blocked and unblocked plants. When I first heard you explain the blocked system, 2 years ago, I took it as all theory, that might do for some one to play with, and not much good for an ordinary farmer who wants to make money.

"If you have any more theories of this kind, send them along as the following report will show what it has meant to me. Next year the seed selected by you will be given a test."

Few tomato growers in North Jersey fertilize with the same material. On the majority of farms, large quantities of manure are applied each year. Owing to the scarcity and high price of manure, these men are beginning to use a system of rotation on which cover crops can be grown and a high-grade fertilizer used in the growing of crops. In the spring a survey was made of the tomato growers in Bergen County as to the variety, method of fertilization, crop rotation, approximate yield, etc. As the result of this information, the fertilizer formulas used were those which were most commonly used by the commercial growers, namely, the 5-8-0, 4-8-4, 5-8-4, 4-10-0 and straight acid phosphate at the rate of 800 pounds to the acre. The results of this work are given in table 2.

The variety used in the demonstration was the John Baer.

This demonstration was county-wide and every tomato grower in the county displayed much interest even to the extent of wagering on the results of the various fertilizer plots. Charles Breisacher's plot was included on the tour of the County Board of Agriculture, at which time the plots were examined. The specialist also gave a talk on the value of home selection and saving of tomato seed.

Vegetable Project No. 3—Sweet potato Demonstration

This was the first year that work had been done with this crop in a demonstration way outside of disease or stem rot control. This phase of the work has recently been taken over by representatives from the Department of Plant Pathology.

Ocean County

This work was started in Ocean County due to the fact that the agriculture in this county was not as progressive as that of other counties. The market facilities are more or less poor, although there is a good local market for this commodity. The soil is very light sand and ideal for the growing of good sweet potatoes.

During the winter of 1919-20 County Agent E. H. Waite conducted a campaign over the county. The specialist assisted in this campaign by giving illustrated lectures on the growing of sweet potatoes. Statistics show that the largest acreage of sweet potatoes in the county averages around 3 acres The majority of plots averaged around an acre, and in many cases just a few hundred plants in the garden for the immediate use of the grower. It was decided by County Agent Waite and the specialist, together with a few of the larger sweet potato growers, that 2 good projects on sweet potatoes covering the variety work and fertilizer work should be started this year.

Variety Work

In anticipation of this work, the specialist wrote to W. R. Beattie of the Bureau of Plant Industry, Washington, D. C., for the varieties of sweet potatoes which he thought would do well under existing conditions. Accordingly, the Department sent tubers of the Triumph, Porto Rico, Nancy Hall, Southern Queen and Pumpkin varieties. In outlining the variety work, we thought it would be interesting to the growers of the county, which included seed of the Early Carolina from Martin Welbrook, the Jersey Red and the Jersey Yellow, large and small seed from Holmes Irons, and the Nansemond from Dilton Wilbur. The test of the results from the large and small seed came as the result of recommendations from old growers in the county who had always been in the practice of saving seed, and thinking that the medium or smaller seed was not desirable. Large and small seed was secured of the Yellow Jersey, and the results of these 2 tests are very interesting. The variety demonstration was planted on good ground which had received a generous application of manure in the row, while the fertilizer work was conducted on absolutely the poorest soils available. The tubers were bedded by Mr. Waite on the farm of Mrs. J. Johns when the plants were normal size. They were transplanted into the field and the regular cultural methods given as on other varieties. On October 9, the variety demonstration was dug, and on the twelfth they were graded and weighed up by the county agent and vegetable specialist. The results of this demonstration are as follows:

Below is given the yields of the different varieties of sweet potatoes planted in the variety comparison demonstration at Mrs. J. Johns, Toms River, 1920. Ranking is given in table 3.

Table 3

Rank	VARIETIES	Firsts	Seconds	Total
		bushels	bushels	bushels
1	Triumph— Bureau of Plant Industry	449.0	38.0	487.0
2	Early Carolina— Seed from Cedar Grove	355.6	26.5	382.1
3	Jersey Red— Seed from Holmes Irons, Toms River,	253.3	49.4	284.7
4	Porto Rico— Bureau of Plant Industry	197.0	45.3	242.3
5	Nancy Hall— Bureau of Plant Industry...........	162.6	35.5	198.1
6	Nansemond— Seed from Dilton Wilbur	138.0	26.4	164.4
7	Jersey Yellow— Small seed from Holmes Irons	100.0	53.8	153.8
8	Jersey Yellow— Large seed from Holmes Irons	100.0	38.4	138.4
9	Southern Queen— Bureau of Plant Industry	68.5	30.7	98.7

NOTE.—Variety comparison was on land that had been heavily manured and cultivated in previous years.

Fertilizer Demonstrations*

On the farm of Mrs. J. Johns a fertilizer demonstration was also conducted. The results of these fertilizer demonstrations are immeasurable, due to the fact that the old growers of the county are very skeptical as to the results of the sweet potato yield when manure is not used in the row. Many of the old growers laughed at the county agent and specialist when the proposition was put to them. However, they were interested that the work should go on, and to know the results. No sweet potatoes had been grown before on fertilizer and without the use of manure in Ocean County. All of the fertilizer demonstrations were carried on in duplicate so as to check on any uniformity in soil conditions. Following are the results secured on the 3 demonstrations conducted in the county:

Below is given the yields obtained from different grades of fertilizers used in the sweet potato demonstration at Mrs. J. Johns. Ranking is given in table 4.

Table 4

Rank	GRADES	Firsts	Seconds	Total
		bushels	bushels	bushels
1	4-8-4	87.8	33.8	121.6
2	Barn yard manure	80.0	32.3	112.3
3	2-8-4	69.2	43.8	113.0
4	4-8-6	65.1	36.3	101.4
5	Hog manure and acid phosphates	42.9	22.9	65.8
6	4-10-0	39.4	38.2	77.6
7	6-8-4	37.1	38.1	75.2

Average yields of different grades of fertilizer used for sweet potato demonstration at the farm of Sheriff Brown are given in table 5.

Table 5

Rank	GRADES	Firsts	Seconds	Total
		bushels	bushels	bushels
1	4-8-4	73.7	26.6	100.3
2	6-8-4	55.4	33.3	88.7
3	2-8-4	48.0	19.7	67.7
4	Manure plus 4-10-0	47.7	79.8	127.5
5	Manure	42.9	49.4	92.3
6	4-8-6	19.7	28.8	48.5
7	4-10-0	12.1	23.4	35.5

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*The soil on which all demonstrations were conducted was a light clear sand, which had not been cultivated or manured for many years.

Average yields from different grades of fertilizer used for sweet potato fertilization demonstration at the farm of W. H. Clayton. Ranking is given in table 6.

Table 6

Rank	GRADES	Firsts	Seconds	Total
		bushels	bushels	bushels
1	Manure	88.7	20.1	108.8
2	6-8-4	65.2	43.5	108.7
3	4-8-4	64.4	37.6	102.0
4	4-8-6	62.6	35.3	97.9
5	2-8-4	58.6	36.5	95.1
6	4-10-0	32.4	43.3	75.7

The average results taken from 3 sweet potato demonstrations are given in table 7.

Table 7

GRADE OF FERTILIZER	Firsts	Seconds	Total
1,000 lbs. per A.	bu. per A.	bu. per A.	bu. per A.
4-8-4	72.5	34.7	107.2
Manure	66.5	38.8	105.0
4-8-6	62.9	36.8	99.7
2-8-4	61.8	32.7	94.3
6-8-4	59.3	40.3	98.0
4-10-0	27.1	33.0	60.1

Other Results on But One Demonstration

Manure plus 4-10-0	47.7	79.8	127.5
Hog manure and acid phosphate	42.9	22.0	65.8

Camden County

As the result of a community meeting in the extreme eastern part of Camden County where the sweet potatoes are grown in considerable quantities, the community asked for work to be done in reference to potash work with sweet potatoes. In this community very little manure is used for the growing of this crop. The use of various formulæ of fertilizer is the common practice. The project was outlined and submitted to the community for approval.

Mr. Priestley is an old sweet potato grower, and his land is in fairly good condition. He has always used a very high grade of fertilizer. the common formula being 5-8-6. Mr. Priestley believes in cover crops, and part of his sweet potato ground received an application of tobacco stems. Results are given in table 8.

Table 8

Rank	GRADES	ACRE YIELDS		
		Firsts	Seconds	Total
		bushels	bushels	bushels
1	5-8-4	195	36	231
2	6-8-6	174	45	219
3	4-10-6	168	48	216
4	4-10-8	159	51	210
5	4-10-4	132	69	201
6	3-9-2	126	54	180
7	4-10-0	99	39	138

The other demonstrator was Oscar Batelle of Waterford, New Jersey. Mr. Batelle's plot of ground was considerably poorer than Mr. Priestley's however. The results of the demonstration are very gratifying. Mr. Batelle's regular fertilizer was a 4-10-0, which he has been using for years. The results of the demonstration show clearly that the *presence of potash* is necessary for higher yields.

The results obtained from the sweet potato fertilization work both in Ocean County and in Camden County this year clearly show that a fertilizer containing approximately 4 per cent of nitrogen, 8 per cent of phosphoric acid and from 4 to 6 per cent of potash will give the best results, even better than where manure is used alone. The problem in the future with this work will be to get the growers to form a definite system of crop rotation so that a good cover crop may be grown and plowed under on the sweet potato ground. A cover crop forming the organic matter with a good application of a high-grade commercial fertilizer will produce larger crops than they are now producing with less expenditure of money.

On October 27 the Camden County Board of Agriculture had a tour. One of the scheduled stops was at the farm of Mr. Batelle, who had the sweet potatoes from the various fertilizer plots arranged in baskets. The specialist at this time gave a summary of the work done and read the results obtained from the other demonstrations. Questions were answered, and much interest was shown by those present. Requests were made at this time for plans of a flue-heated hotbed for plant growing.

Open Flue-Heated Hotbeds

Late in the fall of 1920 numerous requests were received in reference to the construction of open flue-heated hotbeds for the growing of sweet potato plants. Plans were drawn and blue-prints made. It was necessary that a charge of 25 cents be made for each blue-print. At the present date the following blue-prints have been mailed:

New Jersey	24
New York	3
Pennsylvania	5
Ohio	2
Indiana	4
Kansas	5
Massachusetts	1
Missouri	2
Nebraska	1
Maryland	1
Texas	1
	49

Vegetable Project No. 4—Pepper Work

No work has heretofore been done for the pepper growers of New Jersey. This industry is one of considerable size in this state, statistics showing that approximately 53 per cent of the peppers produced in the United States are grown here. Work was started this year in Cumberland County, and repeated from last year in Cape May County. Extension work, especially with the fertilizer phase in the growing of this crop is extremely difficult due to the fact that there is no definite system of crop rotation. The soils vary a great deal in the amount of plant-food and the distances of planting, and the varieties vary a great deal. This is a very good crop for those soils, and when the price for peppers is normal, will constitute quite a revenue for the growers.

Fertilizer Work

The growers of this crop generally use considerable manure with little fertilizer, especially on the light sandy soils. Due to the scarcity of manure, it is necessary, in order to raise proper crops, to eliminate the manure and resort to the growing of cover crops supplemented by commercial fertilizers. The main object in these demonstrations was to demonstrate the influence of various amounts of nitrogen, phosphoric acid and potash in the production of this crop. The results are given in table 9.

Table 9

J. J. Gerard—Cumberland County

FERTILIZER	Plot No. 1 In Bushel Hampers	Plot No. 2 Bushel Hampers	Average Yield in Bushel Hampers	Average Yield per Acre Bushels	Increase Over Check
2-8-3	10¾	10¼	10½	567	162
4-8-0	9½	8¾	9⅛	493	88
4-8-5	10¼	9½	9⅞	534	129
Check	7½	7½	7½	405	...
4-8-7	10⅞	9⅞	10⅜	511	106
6-8-3	10½	9¾	10⅛	547	142
4-12-3	9¾	11	10⅜	561	156
4-8-3	11	10¾	10⅞	588	183
Buffer rows	7¼	7½	7⅜	399	—6
	8	7⅔			
	6½	7⅝			
	7½	7¼			

Sam. Lee—Cape May County

FERTILIZER	Yields	Average Yield per Plant	Total Yield per Acre
	lbs.	lbs.	bushel hampers
Check	201	3.09	865
Nitrate of Soda	288	4.88	1366
Sulfate of Ammonia	308	4.81	1347
King Crab and Nitrate of Soda	434	3.94	1103
King Crab and Sulfate of Ammonia	411	3.77	1055
Average hampers per acre from chemical fertilizer	....	....	1356
Average hampers per acre from crab and chemical fertilizer	....	....	1029

Remarks: It pays to derive ammonia from sulfate of ammonia or nitrate of soda if July applications in top dressings are made.

1,500 lbs. of 5-8-3 were used per acre.

Application as top dressing was made on July 1, 1920.

Conclusions: Nitrate of Soda best for late top dressing. Sulfate and crab, especially, should be applied early in season. Crab should be used under the soil rather than on top.

Table 9 (Continued)

Ralph Schellinger—Cape May County

FERTILZER	Average Yield per Plot	Total Yield per Acre	Increase per Acre Over Check
	lbs.	bushel hampers	bushels
2½-12-3	133	492	230
4-12-0	123	455	193
4-12-5	135	500	238
4-12-3	142	525	263
(Nitrate) (6-12-0)	155	574	312
(Sulfate) (6-12-0)	129	477	215
4-12-7	106	392	130
6-12-0	115	425	163
King Crab Sulfate and Nitrate	...	...	...
Check	71	262	...

The soil on this plot has always received heavy applications of manure.

All fertilizers for the different plots had for a base a 2½-12-3 commercial fertilizer. The above changes of analysis were made by adding the above-named materials. One-half ton per acre was the amount applied.

The last picking was killed by frost and could not be weighed.

Vegetable Project No. 5—The Improvement of Sweet Corn by Ear to Row

This demonstration was the result of a county corn show held at the annual meeting of the County Board of Bergen County, January 3, 1920. There were 12 exhibits at this show, and very poor corn was shown. As the result of this meeting this project was outlined for the purpose of increasing interest as well as educating the growers for the better selection of seed. One demonstrator was secured, namely: Henry Behnke, with the Howling Mob variety. The results of this demonstration were very interesting and conclusive. Very much interest was shown by the corn growers of the county. The results of this demonstration are as follows:

The results of the first year's work on the Howling Mob variety are given in table 10.

Standardization

Because of the interest shown in the sweet corn work at a field meeting in the summer, the County Board of Agriculture appointed a standardization committee, consisting of John Handwerg, J. Pell Zabriskie, Chas. Braesacher, Wm. Behnke, Wm. Ehret and F. S. Weisgerber. At a meeting on February 28 this committee decided on the 5 leading varieties on which to continue work in Bergen County. These are given in the following list, together with the demonstrators who will carry on the work:

Early White Cory	Henry Behnke
Early Mayflower	E. A. Korn
Howling Mob	Henry Behnke
Early Mammoth	F. S. Weisgerber
Long Island Beauty	John Handwerg

Table 10

Data of the Original Ears (1919)

Number of Ear	Rows on Ear	Length of Ear in inches
1	16	7.5
2	18	8.
3	16	7.75
4	16	7.
5	12	7.5
6	12	7.75
7	14	8.
8	16	7.
9	16	7.
10	14	7.5

Number of Rows on 1920 Ears

Progeny of Ear No.	Ears with 18 Rows	Ears with 16 Rows	Ears with 14 Rows	Ears with 12 Rows
1	2	5	3	..
2	..	3	2	5
3	..	4	4	2
4	..	2	..	8
5	..	..	6	4
6	..	3	5	2
7	..	4	2	4
8	1	2	5	2
9	..	4	3	3
10	..	1	5	4

Data on the Resulting 1920 Stalks

Row	Average Height of Stalk	Average Height of Ear on Stalk
	inches	inches
1	79	24.75
2	94	31.00
3	80	21.25
4	79	27.00
5	82	27.50
6	76	26.00
7	76	27.25
8	77	26.50
9	76	25.00
10	72	25.50

Vegetable Project No. 7—Horse-Radish Fertilization

On the farm of George Haines of Brookdale a demonstration was conducted in which various amounts of various fertilizer combinations were used. Table 11 shows a plan of the demonstration giving the treatments of various rows in the demonstration block.

FERTILIZER	MANURE	Marketable Roots per Acre	Sets per Acre
		lbs.	lbs.
4-10-0	No Manure	7022	1653
4-10-0	Manure	8932	2436
4-10-3	No Manure	7141	1552
4-10-3	Manure	8050	2415
6-10-3	No Manure	7385	1688
6-10-3	Manure	8404	2194
4-10-6	No Manure	7314	1896
4-10-6	Manure	9389.5	2004.5
4-10-10	No Manure	7426	1222
4-10-10	Manure	7123	2448
Check	No Manure	6634	1198
Check	Manure	7503	1216
3-8-3	No Manure	7180	1427
Acid Phos.	Manure	7867	2070

Vegetable Project No. 9—Seed-Bed Sterilization

Owing to the high price of formaldehyde very little soil sterilization work was done. In following up the results of one of the men who had sterilized the season before, it was noticed that very little disease was present in the beds. On the farm of John Sedyen, where the work was first done in the fall of 1918, the bed sterilization at that time contained practically no disease, showing that under proper care a sterilization bed will give good results for a number of years.

Miscellaneous Work

Boys' and Girls' Clubs

Some time was spent with the drawing up of projects and meeting with clubs for the purpose of outlining Junior Extension work. At the present time there are tomato, sweet potato, sweet corn, pepper and asparagus clubs, organized and doing good work. The county agent is held entirely responsible for the work after the project is outlined.

Publicity

Timely Tips for Gardeners were written and sent out through the Editor's office each week during the growing season to the newspapers of the state for the benefit of the home gardeners. Two circulars were written, one on the culture of horse-radish and the other on the home selection and saving of tomato seed. During the winter some of the specialist's time was given to institute lecture work, county and community meetings. The rest of the time was spent with county organization in the various counties as well as the writing of projects and organization of work for the year.

Part 2

The following list gives the number and kinds of demonstrations under way at the present time:

Vegetable Demonstrations in New Jersey, 1921

C. H. NISSLEY, Leader

		Total No.
Canhouse Tomato		6
Camden	1	
Cape May	1	
Burlington	1	
Mercer	1	
Salem	2	
Tomato Seed Saving		20
Cumberland	10	
Bergen	3	
Mercer	4	
Middlesex	2	
Morris	1	
Tomato Leaf Spot Disease Control		5
Bergen	3	
Middlesex	1	
Sussex	1	
Sweet Potato Fertilizer		10
Atlantic	3	
Ocean	6	
Salem	1	
Sweet Potato Cultural		10
Atlantic	4	
Ocean	2	
Cape May	2	
Salem	2	
Pepper Variety		1
Cape May	1	
Canhouse Tomato Field Planting Dates		1
Cumberland	1	
Tomato Fertilizer		4
Passaic	2	
Sussex	2	
Tomato Blocking		1
Morris	1	
Sweet Potato Variety		7
Ocean	1	
Atlantic	1	
Cape May	1	
Cumberland	1	
Salem	1	
Camden	1	
Burlington	1	
Sweet Potato Stem Rot Control		1
Salem	1	
Pepper Fertilizer		6
Atlantic	3	
Cape May	1	
Cumberland	2	
Sweet Corn Variety Improvement (Ear-to-Row)		6
Bergen	5	
Burlington	1	

		Total No.
Pepper Disease		1
Middlesex	1	
Muskmelon Fertilizer		3
Passaic	2	
Atlantic	1	
Cabbage Maggot Control		9
Gloucester	1	
Camden	3	
Burlington	1	
Mercer	1	
Passaic	2	
Sussex	1	
Cucumber Beetle Control		5
Cape May	1	
Atlantic	2	
Sussex	1	
Cumberland	1	
Eggplant Disease		1
Middlesex	1	
Aphis Control		12
Bergen	2	
Gloucester	3	
Mercer	2	
Middlesex	3	
Monmouth	2	
Soil Sterilization		13
Bergen	4	
Passaic	6	
Atlantic	1	
Burlington	1	
Salem	1	
Cabbage Fertilizer		2
Passaic	2	
Cucumber Fertilizer		1
Sussex	1	
Horse-radish Fertilizer		3
Passaic	3	
Celery Leaf Spot Disease Control		6
Bergen	2	
Passaic	2	
Warren	2	
Lima Bean Mildew Control		2
Cumberland	1	
Camden	1	

REPORT OF THE SPECIALIST IN FARM CROPS AND SOIL FERTILITY

HERBERT R. COX

Most of the projects reported herein were of the crop season of 1920. A brief statement regarding the 1921 program is appended.

Potatoes

Source of Seed. This continues to be the leading demonstration project with potatoes. Five counties with a total of 14 demonstrations engaged in source of seed demonstrations; they were Monmouth, Middlesex, Warren, Cape May and Camden. The scheme of the demonstration differed widely in the various counties according to conditions. In Warren County a simple type of demonstration was put on; it consisted in bringing in one lot of good seed of the Russet variety and distributing it to 4 farms, where it was grown in comparison with the farmer's own seed. Very striking results in yields were shown by the improved seed, amounting to about 100 per cent increase as an average of all 4 demonstrations. In Middlesex and Monmouth Counties the farmers recognize the value of good seed; the problem is, where are they to get it. In these counties, therefore, the seed source demonstrations included seed from a large number of sources of each of the 3 leading varieties: Giants, Green Mountains and Cobblers. The work in Camden and Cape May Counties was with the Cobbler variety and was designed to show the value of good South Jersey late crop seed, as compared with ordinary commercial seed.

In addition to source of seed demonstrations certain minor projects were carried out during the year, including some spraying in Middlesex County and scab control in Salem, Ocean and Monmouth Counties.

Corn

Variety Demonstrations, Ear Corn. There was a total of 58 corn variety demonstrations in 12 counties. The methods of carrying on this work were the same as described in previous reports. The stands of corn in the various plats were more uniformly perfect in 1920 than during any previous year. There is no doubt but that this corn variety work is yielding valuable information as to the varieties adapted to the different sections of the state.

Variety Demonstration, Silage Corn. In some of the dairy counties there is a demand for similar demonstrations on silage corn. Five of these were carried on in 1920—2 in Essex, 2 in Sussex and 1 in Somerset. Yields were computed on a basis of dry weight per acre of the different varieties.

Inter-County Corn Yield Contest. During the summer of 1920, 2 county agents—Camden and Ocean Counties—spoke to the specialist about an unusually fine field of corn in each of these counties and indicated that they would be willing to have these fields entered in competition with any other corn field in the state. The possibility of stimulating interest in corn production, not only in these counties but also throughout the state, by arranging a contest for the highest yield of a measured acre of corn was immediately recognized. There were 5 counties which entered this contest, nearly every county entering more than 1 field; they were Passaic, Middlesex, Camden, Ocean and Salem. The highest yield was reported by Salem County at 142.8 bushels per acre. There were 7 fields which produced over 100 bushels per acre.

Soil Improvement

Cover Crop Comparisons. This project consists of a number of plats side by side seeded to the various cover crops best adapted to the locality. They are seeded at the last working of a cultivated crop or after the crop is harvested. The purpose is to acquaint farmers with the characteristics of the different cover crops and stimulate interest in the use of cover crops. There were 16 of these demonstrations undertaken in the state in 1920 in 7 of the counties. Field meetings were held in the spring of 1921 at 8 of these demonstrations with a total attendance of 164 persons.

Value of Cover Crops. The purpose of this project is to show definitely that cover crops may be relied upon to increase the productiveness of the soil. It involves the keeping of records on the cover crop plats for 3 years or more, as well as on the check plats not seeded to cover crops. Gloucester County initiated 2 or 3 of these demonstrations in 1920. In 1921 a number of counties will undertake this project.

Cover Crop Campaigns. In some counties of the state farmers believe cover cropping to be good practice, but have not as yet generally adopted it. Here a cover crop campaign may well be undertaken as a demonstration activity. Four counties conducted campaigns during 1920—Gloucester, Burlington, Bergen and Cape May. The seed ordered consisted largely of vetch, crimson clover and cow peas. The total amount of seed ordered by the farmers in the 4 counties as a result of this effort was over 23 tons. There is no doubt, also, but that a great deal of seed not figuring in the above total was purchased independently as a result of the agitation.

Miscellaneous

Wheat and Rye Variety Demonstrations. In Somerset County a wheat variety demonstration was established, including 6 varieties believed to be well adapted to the section. In Ocean County rye variety comparisons of 2 different kinds of rye, viz., Rosen and common, were established on 2 farms. Field meetings were held at all these demonstrations just before harvest in 1921.

Alfalfa Strains. Two demonstrations were established in Sussex County to show the characteristics of the various strains of alfalfa, especially to indicate the strains best adapted to northern New Jersey. Eight different strains of seed are here represented.

Among miscellaneous activities not connected with projects which the farm crops specialist was called upon to handle may be mentioned first of all correspondence; a fifth of his time probably was taken up in answering various inquiries on soil and crop subjects from the people of the state. He furnished a number of memoranda to the demonstration offices in the counties regarding timely subjects. He prepared 9 articles for the green sheet news service of the College. He spent some time in preparing for the state corn show of 1921; and he was elected secretary of the New Jersey Alfalfa Association at the annual meeting in January, 1921.

Plans For Crop Season of 1921

Early in the year the farm crops specialist visited each of the counties, meeting the county agent and project leaders to outline the farm crops and soils program for the year. The programs for the year in the various counties included the 1920 projects listed above as well as several additional ones. It may be said that the county programs for 1921 have been more carefully planned than for any previous year.

REPORT OF THE SPECIALIST IN POULTRY HUSBANDRY

WILLARD H. ALLEN

The poultry extension work in New Jersey during the past year has been carried on along the lines laid down shortly after the work was started in this state. According to this program the poultry extension work is classed into 6 main groups as follows:

1. The commercial poultry farm.
2. The general farm flock.
    a. The large specialized flock.
    b. The small farm yard flock.
3. The exhibition poultry flock.
4. The suburban back yard flock.
5. The boys' and girls' poultry club flock.
6. The highly specialized poultry industry.
    a. The commercial hatcheries.
    b. Capon production.
    c. Commercial broiler production.
    d. Commercial fattening establishments.

Demonstration projects have been outlined in detail following the lines of subject matter that are considered important in regard to the efficient and economical success of the industry. These demonstrations are carried on through the cooperation of various poultrymen in communities which have been selected beforehand by the county agent and the state specialist with the object in mind as to their location and adaptability to doing demonstration work.

All demonstration projects have been outlined in detail following the lines of subject matter that have been considered important. The projects are as follows:

The keeping of systematic records of cost of production and amount of return.
The development and use of good strains of stock.
The elimination of the poor producer through the practice of culling.
The construction of proper poultry houses.
The use of properly-balanced rations.
The use of artificial illumination to insure more efficient egg production.
The use of green crops in the poultry yards.

The above demonstrations are being carried on in over 50 communities throughout the state. The work has been very beneficial to the communities and the individuals themselves, because it has been the means by which standards have been worked out in regard to egg production, feeding, housing, lighting, time of hatching, and many other factors so vital to good management.

The demonstrations are being carried on by one or more cooperators in a community by the following means:

1. Individual poultrymen.
2. Community poultry clubs.
3. Boys' and girls' poultry clubs.
4. Cooperation with local associations through the promotion of educational programs and the establishment of new associations.

During the past year a great deal of time and effort have been spent upon the keeping of systematic records, the cost of production and the amount of returns through individual demonstratoins. Table 1, which gives the summary of the year's work, was sent out to the poultrymen of the state as well as the demonstrators.

This year the same project is being carried on with about 40 individual poultrymen. On May 15 a 6-months' summary was made out and sent out to various demonstrators and county agents for their information. Table 2 includes this summary.

Community Poultry Clubs

One of the ways in which the poultry department through extension work is trying to get the newer phases of the poultry knowledge practiced by the poultrymen of the state is through poultry clubs. A club usually consists of 10 or more members in a community who desire to learn better poultry management. The club meets once a month at the home of one of the members where a summary is made of the month's work, and through comparison and discussion, reasons are found why one flock is doing better than the others. After the summary is taken, timely subjects are discussed.

Table 3 is the summary of the May results of the Flemington Poultry Club.

Boys' and Girls' Poultry Clubs

At the present time there are several Boys' and Girls' poultry clubs in the state, many of them doing excellent work and demonstrating what better management will do. During the last month a conference was held between the poultry specialist and the State Club Leader, at which time a definite outline was drawn up covering the kind of poultry clubs with which the poultry specialist would work. The object of the plan was to try to shape the club work so that it would be of large enough size and in such communities that it would attract attention to the better methods. The following is the plan worked out by the state club leader and the poultry specialist:

1. The club shall be located in a rural community.
2. A survey of the home conditions will be made before the club is started.
   a. To sense the feeling of the parents.
   b. To see the possibilities for enlargement.
3. A local committee that will stand as sponsor will be procured before the work is started in any community.
4. Local leadership must be guaranteed by the local committee.
5. Eight and not over 15 members, owning at least 300 birds shall be considered a working unit.
6. The members shall be at least 12 years old.
7. Birds must be owned by members themselves or in partnership with their parents.
8. Every club shall have a definite goal and purpose of work.
9. Every club member will be expected to keep records on his entire job, reporting them by the last meeting of the year, which will be held in the early part of the month of November.
10. At the end of the season a community meeting will be held to explain accomplishments of the club.
11. The county club agent will have direct charge of the club in his county and will be responsible for the organization and follow up work.
12. The poultry specialist will prepare subject matter for letters, club meetings, programs, and will visit the projects from time to time.
13. The county club agent will be directly responsible to the state club leader for the work done with poultry clubs in his county.

Cooperation

The poultrymen of New Jersey are organized as is no other branch of the agricultural industry. Practically every county in the state has one or more active poultry organizations carrying on regular monthly meetings with excellent educational programs. These associations make a heavy call upon the poultry specialist in attending regular meetings and taking part in the program. It is through these organized meetings, however, that the specialist is able to meet large numbers of active poultrymen and to gain their help in taking up the various projects in the extension work. In many of the counties these associations are active in the support of extension activities, giving their support to the work of Farm Demonstration, Home Demonstration and Boys' and Girls' Club work that may be carried on in their counties. It seems possible that through closer cooperation between these organizations and the extension activities the subject matter of the extension program may be placed before the poultry interests in a manner that could in no other way be

Table 1

Summary of Cooperative Poultry Farms, 1919-20

ITEMS	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Monthly Average
Total Number Birds	8919	8532	9808	8637	8019	6305	5886	5765	4817	4116	3477	6671
Total Number Eggs	32318	51840	53641	84882	112573	89771	97165	79966	72107	55789	36650	69700
Per cent Production	12.08	19.6	25.72	33.88	42.82	49.33	53.10	48.35	47.8	42.05	31.45	34.82
Total Value of Eggs	2187.79	4286.24	4265.88	6133.57	7159.61	5830.00	5656.09	4921.48	4617.62	3857.40	2996.16	4719.25
Lbs. Dry Mash Consumed	15538	22204	20960	25082	29210	22690	22626	19152	18629	15265	11865	20292
Cost of Dry Mash	646.40	804.34	785.56	924.60	1098.93	880.34	889.43	789.25	746.98	614.02	458.65	785.31
Cost of Mash per 100 lbs.	3.90	3.69	3.75	3.80	3.94	4.06	3.92	4.02	3.99	4.00	3.85	3.92
Lbs. Scratch Consumed	25282	31308	33072	32304	31068	24005	21490	19315	17954	13933	11615	23758
Total Cost Scratch	1037.89	1132.68	1213.61	1171.60	1231.35	923.04	891.03	821.62	758.91	584.16	466.67	931.05
Cost Scratch per 100 lbs.	3.83	3.73	3.45	3.61	3.71	3.72	4.16	4.25	4.23	4.18	3.99	3.89
Total lbs. Mash and Scratch....	40820	64179	54033	57360	60278	46695	44136	38567	36583	31198	23480	45211
Miscellaneous Feed Consumed ..	139.64	124.75	174.23	154.98	142.65	113.25	50.09	70.47	61.85	54.61	49.47	103.21
Total Cost Feed Consumed	1822.18	2061.78	2116.41	2249.69	2391.99	1925.63	1830.55	1681.36	1567.74	1251.89	974.99	1806.74
Profit above Feed	365.60	2224.52	2161.21	3815.26	4771.61	3904.37	3825.54	3240.14	3049.98	2704.61	2021.17	2825.81
Lbs. Scratch per Bird	3.21	3.54	3.81	3.90	4.34	3.87	3.66	3.61	3.88	3.51	3.42	3.70
Lbs. Mash per Bird	2.25	2.79	2.95	3.98	3.78	3.34	3.99	3.58	4.01	3.82	3.52	3.46
Total lbs. Feed per Bird	5.46	6.28	6.76	6.67	7.41	7.20	7.68	7.20	7.89	7.32	6.94	6.98
Cost Scratch per Bird	.117	.13	.14	.127	.135	.143	.151	.153	.158	.146	.135	.148
Cost of Mash per Bird	.088	.095	.106	.120	.147	.133	.156	.144	.165	.153	.135	.14
Cost of Misc. Feed per Bird....	.02	.045	.062	.033	.067	.043	.004	.015	.014	.015	.015	.035
Total Feed Cost per Bird......	.235	.242	.268	.264	.304	.304	.312	.314	.337	.313	.285	.288
Gross Return per Bird	.346	.552	.551	.644	.729	.795	.952	.864	.948	.923	.781	.735
Profit above Feed per Bird.....	.169	.309	.294	.381	.425	.489	.69	.55	.61	.613	.498	.457
Feed Cost per doz. Eggs	.606	.431	.415	.335	.306	.262	.232	.263	.274	.302	.461	.353

Table 2
Six Months' Summary of Poultry Demonstration Farms

ITEM	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Total
Number Birds	17979	15937	16656	16235	13445	11743	91995
Number Eggs	77808	108360	148336	178632	221136	200876	935148
Per cent Production	14%	22%	28%	39%	53%	57%	35.5%
Eggs per Bird	4.3	6.7	8.8	11.0	16.4	17.6	64.8
Lbs. Grain Fed	64935	59216	62213	59335	51843	41687	339229
Cost Grain	2168.15	1981.18	1895.19	1633.92	1456.06	1094.41	10228.91
Cost 100 lbs.	3.33	3.33	3.06	2.75	2.80	2.62	3.01
Lbs. Mash Fed	39602	38697	43037	41878	41336	38342	242892
Cost Mash	1388.12	1317.08	1390.12	1316.93	1228.09	1064.55	7704.89
Cost 100 lbs.	3.51	3.40	3.22	3.14	2.97	2.77	3.17
Cost Miscellaneous Feeds	185.64	298.96	308.41	311.00	276.89	196.65	1577.55
Total Feed Cost	3741.91	3579.22	3592.72	3261.85	2961.04	2355.61	19493.35
Value of Eggs	6744.32	8764.62	10161.30	9163.04	9362.61	7966.29	52162.18
Profits	3002.41	5185.40	6567.58	5901.19	6401.57	5610.68	32668.83
Price doz. Eggs	.97	.92	.777	.56	.45	.40	.68
Feed Cost doz.	.577	.396	.29	.219	.16	.13	.25
Returns per doz.	.393	.524	.687	.241	.29	.27	.43
PER BIRD							
Number Eggs	4.3	6.7	8.8	11.0	16.4	17.6	64.8
Lbs. Grain Fed	3.6	3.7	3.7	3.6	3.8	3.5	21.9
Lbs. Mash Fed	2.2	2.4	2.5	2.5	3.0	3.7	16.3
Total lbs. Feed	5.8	6.1	6.2	6.1	6.8	7.2	38.2
Cost of Grain	.12	.124	.113	.10	.108	.09	.648
Cost of Mash	.077	.082	.083	.081	.091	.09	.504
Cost Miscellaneous Feed	.01	.018	.018	.019	.019	.016	.10
Total Feed Cost	.207	.224	.214	.20	.218	.200	1.26
Value of Eggs	.375	.549	.610	.564	.696	.678	3.47
Profit	.166	.325	.394	.363	.476	.48	2.21

Table 3
Flock Monthly Sheet

FLEMINGTON POULTRY CLUB, MAY, 1921.

CO-OPERATOR	No. birds for mo.	Eggs		Grain		Mash		Incidental Expenditures	Total Expenditures	Exp. per bird	Egg sale	Returns above feed costs			
		No.	Per hen	Lbs.	Cost	Lbs.	Cost					For mo.	To date	For mo. per bird	To date per bird
No. 1	1,240	21,140	17.5	3,900	88.60	3,500	86.65	43.20	218.45	.17	526.80	308.35	308.35	.25	.25
No. 2	728	10,573	14.5	2,232	54.25	2,500	61.50	10.00	125.75	.13	319.60	193.85	193.85	.30	.30
No. 3	615	10,943	17.0	3,000	57.96	800	19.28	3.25	80.49	.14	318.35	237.86	237.86	.38	.38
No. 4	625	8,768	14.0	1,200	25.44	2,200	53.34	......	78.78	.12	307.00	228.22	228.22	.36	.36
No. 5	60	1,261	21.0	300	6.38	600	11.85	......	18.23	.30	62.40	44.17	44.17	.75	.75
No. 6	75	1,013	14.0	500	9.00	......	....	.25	9.25	.13	33.34	24.09	24.09	.34	.34
No. 7	131	2,553	19.5	446	10.05	284	7.10	1.74	18.89	.14	63.60	44.71	44.71	.48	.48
Total	3,474	56,251	16.2	11,578	251.68	9,884	239.72	58.44	549.84	.16	1,631.09	1,081.25	1,081.25	.31	.31

possible. It is the plan of the specialist, as time goes on, to make this cooperation more nearly universal, in order that the organized poultry interests of the state may endorse and assume some responsibility toward carrying on the poultry program throughout the state.

The Development and Use of Good Strains of Stock

During the fall of 1920, 300 pedigreed white Leghorn cockerels were distributed throughout the state. In most cases the arrangements were made through the county agents, who handled the publicity and secured the cooperators. No report can be made of results of this project as yet. At a later date when it has been possible to study the performance of the progeny from these cockerels, data will be obtained as to the fertility and hatchability of eggs, quality of chicks, development of pullets during the growing season, and egg production after maturity.

During the spring of the present year 25,000 hatching eggs were shipped to various poultrymen throughout the state, the procedure being the same as in the case of the cockerels, the county agent arranging for the men to whom the eggs were shipped. Here again reports will be obtained at a later date, upon the results of the use of this stock. Both the cockerels and hatching eggs are from the best stock at the Experiment Station, resulting from work that has been carried on through several years in obtaining a strain of high-producing birds. This extension project has been carried on for the last 2 or 3 years, and comments from poultry extension men and investigators from other states and Canada are very favorable as to the results which they have observed while traveling through New Jersey as to the effect and influence that this stock has had through improving the general stock throughout the state. A fee covering the cost of raising and pedigreeing these males was charged, amounting from $3 to $5 each. The hatching eggs were sold at the average price then received by commercial poultrymen so that those receiving the eggs were able to obtain them at reasonable prices, considering the quality of the stock.

The Elimination of the Poor Producer Through the Practice of Culling

The art of studying the ability of a fowl to produce eggs, as evidenced by the body formation and pigmentation has been established only in recent years. There is no doubt but that it is one of the most important facts recently established, working toward the improvement of the poultry industry. This state has taken a leading part in the development of this work and it has been a part of the extension program for the last 3 or 4 years, so that throughout the state leading poultrymen are culling their flocks. This results in an increase in the percentage of egg production, as well as an immediate saving through the marketing of the non-producer. Through the summer of 1920, 49 demonstrations were given on the art of culling, the procedure being to arrange with the county agents for meetings at which the poultry specialist would explain the details of the method, using typical specimens from the flock to illustrate the subject, culling several of the birds himself, and then having the interested members of the audience carry on the work under his supervision. This year several demonstrations have already been given at meetings of various sorts and a large number have been arranged for July and August throughout the state. This includes evening lectures and demonstrations at tours and other large summer meetings.

The Construction of Poultry Houses

There has been a general call for aid in the construction of various types of poultry houses, especially in laying houses which follow the general plan of the New Jersey multiple unit house. An average of 90 HINTS TO POULTRYMEN and circulars, covering the subject of Poultry House Construction, have been sent out each month.

The Use of Green Crops in the Poultry Yards

In certain sections of the state there is much need of a system of growing green crops in poultry yards and ranges, while in individual cases throughout the state the lack of proper green crops is a handicap to the poultryman. Considerable information is given in individual cases through personal contact and written information. In addition to these there were 6 cooperators who have been raising alfalfa and rape on their ranges, following instructions furnished by the specialist. In all cases the results have been very satisfactory, the mortality of the growing birds being less by 10 per cent, a remarkable even growth being secured with a greater egg production, as compared with the results from previous years.

In conclusion, I might say that this is in a brief way an outlined summary of the work carried on by the poultry specialist of this state during the past year. Due to the fact that the writer has been in the state only 2 months, it is impossible to give as complete and accurate a report of the year's work as desired.

During the past year and a half there have been two changes made in poultry specialists. Under these circumstances one can easily see that if it were not for the fact that the work was laid out along definite lines, it would have been impossible to have made a report as complete as the one written.

REPORT OF THE SPECIALIST IN DAIRY HUSBANDRY

M. H. KEENEY

The writer began work April 18, 1921. Being a stranger in New Jersey and not being familiar with the specific conditions in the state, the major portion of the time thus far has been spent becoming acquainted with the people, the agricultural extension organization and policy in the state, and the general dairy situation. The writer feels that he now has the situation sufficiently well in hand to start on a definite program of work and secure results.

Summary of meetings, conferences, farm visits, etc.:

Days spent in field	35
Days spent in office	18
Meetings attended	12
Attendance (total)	320
Demonstrations conducted	1
Attendance	12
Conferences with county agents and other individuals	12
Farm visits	45
Public sales of pure-bred cattle attended	6
Letters written	130
Publicity and educational news articles	12

A number of days have been spent in the field with J. W. Bartlett, Secretary of the New Jersey Holstein Association, for the purpose of making the acquaintance of the Holstein breeders of the state.

Cow-Testing Associations. Several days have been spent in the field in the interest of the cow-testing associations. The Morris-Essex Association, in particular, had never been a strong association and was about to go to pieces. It has been reorganized and strengthened, so they will start the new year, July 1, with a full association. In the case of this association it was necessary for the dairy specialist to go in the field and secure members. This should not be necessary, as it should be done by a committee of farmers and the county agent. If there is not sufficient interest among the farmers to secure the members themselves with the aid of the county agent it is better not to start an association. However, a combination of conditions in Morris County and the fact that the association had never been properly organized made it necessary for the dairy specialist either to take the field or see the association discontinue work. The Mercer County Association was also in a bad way, but is being straightened out by the county agent and a membership committee. The Burlington County Association, which had lapsed for a time, was reorganized and began work May 1, with Peter Gulick as tester. Mr. Gulick is proving an efficient man, and they now have a strong association.

The county agent, Mr. Cross, is mainly responsible for the reorganization.

W. J. Thackaberry replaced James Stuart as tester for the Flemington Association May 1. Mr. Thackaberry is making good with the association and is well liked by the farmers.

Mr. Tuoti, tester for the Salem County Association, is leaving the work July 1. We hope to secure a four-year graduate of the Pennsylvania State College to replace Mr. Tuoti. A new association is being organized in Salem and Cumberland Counties. For some time past it has been very difficult to secure well qualified men for supervisors. However, we are now able to get very good men for this work. Most associations are paying $3.00 per day and expenses.

It is the aim of the dairy extension department soon to have our cow testing associations on such a basis that they will carry on without requiring much of the time of the dairy specialist. Also, each cow tester will in reality be a dairy extension man in his community. It is possible to do this now that we can secure competent men for testers.

The following are the active associations in the state:

Name of Association	*Tester*	*County*
Ringoes	Stanley Douglass	Hunterdon
Sussex County	R. M. Morrow	Sussex
Burlington County	Peter Gulick	Burlington
Mercer County	A. P. Sisson	Mercer
Salem County	Ferd. Tuoti	Salem
Morris-Essex	George Loesser	Morris and Essex
Flemington	W. J. Thackaberry	Hunterdon

Summary reports are received each month and the interesting features are given state-wide publicity and in addition are often published in the leading dairy papers of the country. The annual reports are of great value and always contain forcible illustrations of the value of this dairy improvement work. The last annual report of the Mercer County Association just came to the office of the dairy specialist. It has not been summarized yet. However, an outstanding feature of the report is the herd of J. W. Miller. His herd of 25 cows leads the association with an average production of 8,391 pounds of milk and 358 pounds of butterfat. His herd of 25 cows made a return above feed cost of over $5,000. The 5 best cows averaged 11,230 pounds of milk and produced milk at a feed cost of $1.93 per cwt. The 5 poorest cows averaged 5,876 pounds of milk at a feed cost of $2.98 per cwt. Thus, the 5 high-producing cows produced milk $1.05 cheaper than the 5 poorest ones. Mr. Miller has been in the association 3 years, and each year has seen a substantial increase in production over the preceding year. Another herd in the association averaged 5,906 pounds of milk for 23 cows. The 5 high cows averaged 8,440 pounds of milk at a feed cost of $1.90

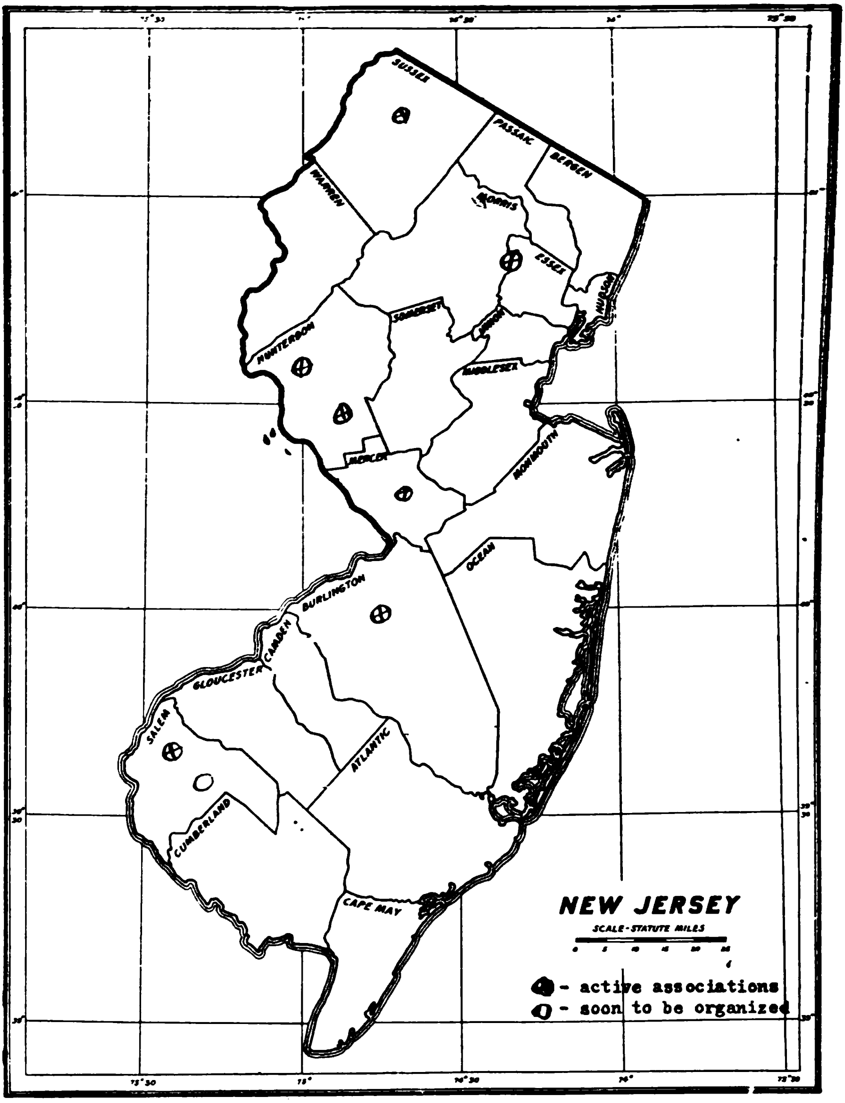

FIG. 1. COW-TESTING ASSOCIATIONS IN NEW JERSEY.

per cwt., while the 5 low cows averaged 3,810 pounds of milk at a feed cost of $3.16 per cwt. Here we have a saving of $1.26 per cwt. in feed cost of milk for the 5 best cows as compared with the 5 poorest ones.

The cow-testing associations are quietly working out a very substantial dairy development in their community where competent men are employed as cow testers. There are at the present time about 175 dairymen in these associations in New Jersey.

Cooperative Bull Associations. There are 6 active bull associations in New Jersey. All are Holstein Associations. These comprise 37 herds owning cooperatively 28 registered Holstein bulls. None of these associations have been organized long enough to have definite results as yet, except that there is a noticeable improvement in the quality of the young stock as compared with the older cattle in these herds. There are two associations in the process of organization in Burlington County, one a Guernsey Association and the other a Holstein Association. A new association is also being organized in Salem County and one in Warren County. Both of these are Holstein Associations.

In all the conferences with the county agents and at most meetings this bull association project has been emphasized. It is our plan to make this the big project of the dairy extension work. We are doing this because it strikes right to the heart of the greatest weakness of our dairy business. That is the quality of the cows a man is working with. The producing ability of a man's cows is the one greatest factor in his net returns in dollars and cents. And the only way to improve the ability of our cows is through the use of high class pure-bred bulls. Since the bull association is a sure and rapid means of improving our herds we feel that every possible effort should be made in the expansion of this project.

Boys' and Girls' Calf Clubs. This is not a project under the dairy extension department. The dairy specialist, however, acts in an advisory capacity to the state club leader and the county club agents. The club agent in Morris County has called for the dairy specialist twice to meet with the club members and advise them on care and feeding of their calves. In Long Valley each of the calves were inspected and suggestions given relative to care and feed and fitting them for show this fall. A number of the clubs have arranged for the dairy specialist to be present at their annual round-up this fall to judge the calves and conduct judging demonstrations. Some assistance has been given the club agents in securing suitable calves for the club members.

Breed Improvement Work. In addition to the breed improvement work through the bull associations and cow-testing associations assistance is given the dairymen in locating and securing desirable breeding stock. Wherever there is sufficient interest in one community

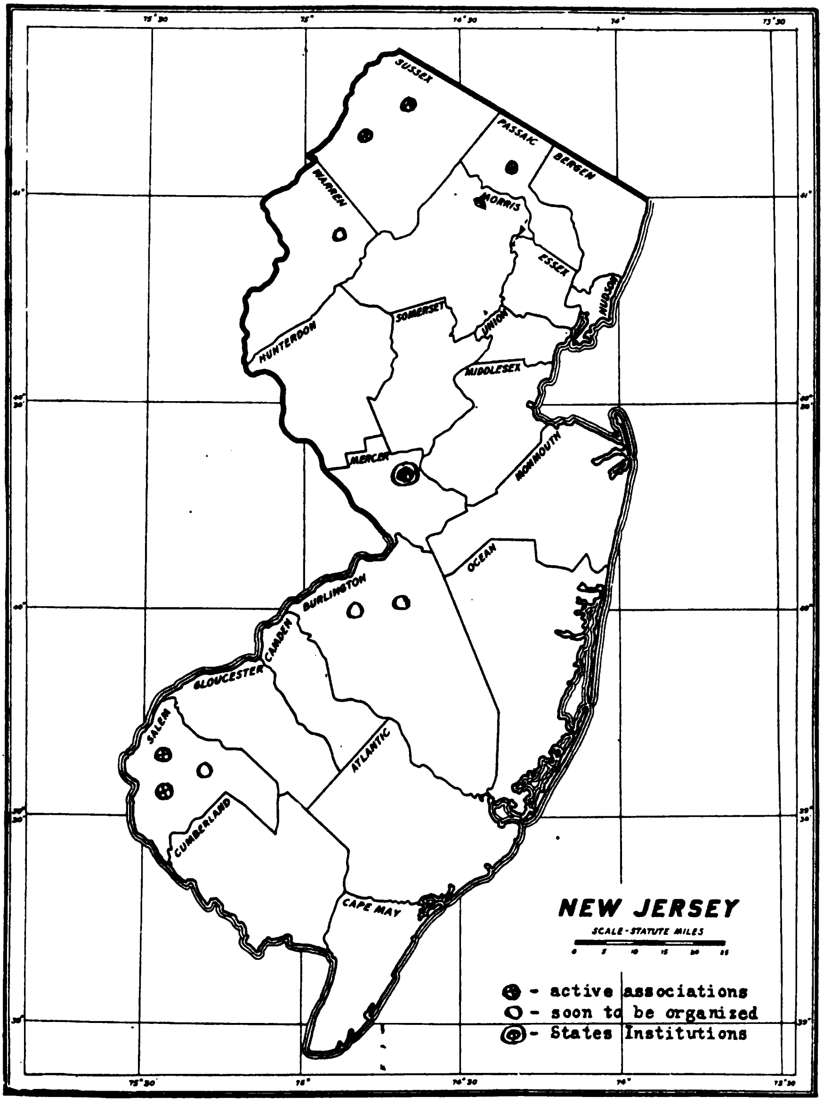

Fig. 2. Bull Associations in New Jersey.

it is the aim of the dairy extension department to get the farmers together and pool their orders so as to buy cattle in carload lots, thereby reducing expenses. This is mainly for the purpose of purchasing pure-bred females. The farmers desiring cattle select a purchasing committee who buy the cattle. The dairy specialist takes no part in the selection and purchase of the cattle. He does, however, endeavor to arouse interest among farmers for the purchase of pure-breds and to get them together to purchase cooperatively and make it a community project. He further gives assistance to these beginners in the keeping of records and registration papers on their pure-bred animals and may give advice as to feed and care, testing the cattle, etc.

A group of farmers in Essex County have made up an order for a carload of registered two-year-old Holstein heifers and expect to purchase them soon. There is considerable interest in Burlington County, and they will probably purchase some more pure-breds this summer.

Two young farmers in Morris County, Elias Johnson's Sons, Dover, had purchased three pure-bred Holstein heifer calves. The dairy specialist advised them to tuberculin test their herd of grade cows and if they had any tuberculosis to clean up. The result was they lost all but 3 cows on the test. However, they took what money they received for the reactors and put it in pure-bred cows. The dairy specialist knew of 6 good young cows for sale. He told these farmers that these were good cows as shown by their cow-testing association records. These farmers purchased these cows and are now on the high road to success in the pure-bred business.

Demonstrations

Feeding Demonstrations. No feeding demonstrations have been conducted by the dairy specialist. However, it is planned to have some later in the season.

Judging Demonstrations. Judging demonstrations illustrating how to select good dairy cows judging them by their conformation or dairy type are often given at meetings, local fairs, county fairs, community picnics, dairy tours, etc.

The dairy specialist has conducted one judging demonstration since he began work in April. This was in Essex County. The farmers showed a very keen interest and gave the specialist a vote of thanks as an expression of their appreciation of the demonstration. One farmer stated that he received more benefit from the demonstration than he could get from a half a dozen lectures.

Meetings and Conferences. Twelve meetings with a total attendance of 320 people have been attended. In most cases the specialist presented subject matter material. Twelve conferences have been held with county agents and community leaders to discuss the dairy projects and consider what work would be applicable to the local conditions.

Dairy Schools

The dairy schools consist of a series of educational and demonstrational lectures to the farmers in a given community. Sufficient interest must be shown to guarantee an average attendance of at least 25 farmers. These schools consist of a series of 6 lectures covering the main phases of the production and marketing of clean milk. The schools are usually held once a week, and a different topic is discussed each week. The subjects are as follows:

1. How to Tell a Good Cow by Looking at Her. Demonstration with lantern slides.
2. Feeding the Dairy Cow.
3. How to Produce Clean Milk and Why It is Important.
4. Diseases of Dairy Cattle and Their Control.
5. Marketing Problems and Their Solution.
6. Principles of Breeding for High-Producing Cows.

The dairy specialist is planning to hold a number of these schools later in the season.

Publicity

Publicity is given to special features of the work through reports, news letters and publications in the farm and dairy papers. The purpose is twofold, viz., educational and advertising or propaganda. All the news articles should have educational value. In addition their purpose is to arouse interest and create favorable sentiment for the dairy projects. Twelve news articles have been written by the dairy specialist since he began work April 18.

REPORT OF ASSISTANT EXTENSION SPECIALIST IN DAIRY HUSBANDRY

STANLEY B. ROBERTS

The writer of this report was assistant specialist to John W. Bartlett until February 1, 1921. From February 1 to April 18 he was the only specialist in dairying in the state. After the new specialist M. H. Keeney had been started and after some work which had been started in other counties was finished, efforts were concentrated beginning May 15 on the counties of Hunterdon, Warren, Sussex and Passaic, as the Director of Extension planned. The responsibility of dairy extension in the rest of the counties of the state was given to M. Keeney. This report therefore will be divided into two parts, one from July 1, 1920, to May 15, 1921, and the other from May 15, 1921, to July 1, 1921.

Report from July 1, 1920, to May 15, 1921

Days spent in the field	194
Days spent in the office	63
Meetings held	39
Attendance	1,279

An average of about 15 letters per week were written. An average of 10 farms per week were visited.

Organization

Cow Testing Associations. On account of the great demand for men and the big wages paid in the cities there has been a great deal of difficulty until lately in keeping testers. For this reason much time has been spent in starting in new testers. Of late we have been able to get more competent testers and have not been annoyed by having them leave their jobs as frequently. A new cow-testing association was organized in Morris and Essex counties which started its year July 1, 1920. Another, organized in Burlington County, started May 1, 1921. I believe the last one mentioned is the best organized cow-testing association in the state, because it was so organized that the farmers have the entire responsibiliy and they have gone ahead and shouldered the work and have started in with a full membership with the money paid in advance for financing the association.

Four associations have taken tours under our direction to visit pure-bred herds to learn how good herds are built up and have found that in many cases they were built up from a small beginning; in fact, in some cases where there were only one or two foundation animals. The Essex County farmers cooperated in the purchase of the first pure-bred bull in their locality, 5 farmers joining in buying one bull, and another buying one. This was done on one of our tours. Several men since then have purchased pure-bred heifers and several others are in the market for pure-bred foundation animals, and certainly will buy when they can find the kind they should have. In fact they are organizing to buy a carload of pure-bred stock.

The Hunterdon County Association members have been purchasing pure-bred bulls. At least 8 bulls have been placed at the head of their herds and in some cases 2 men have been persuaded to buy jointly and use the same bull. Pure-bred heifers also have been purchased as foundation animals. At one of the association meetings the writer gave a talk in which he pointed out the advantages of better stock. One of the farmers said that it did not pay to raise calves and that he always bought a cow and kept her until she went dry. On a previous visit the specialist had seen this man's herd, and it was not a very good one. We visited this man again and interested his son in raising a good herd and as a result he has today 5 pure-bred females and his first pure-bred bull. When starting a new tester on an Essex County farm which was keeping a very inferior herd, we had an opportunity to talk "better stock" to the farmer. When we visited this farmer a few months later he was the proud possessor of 4 beautiful pure-bred females and a pure-bred bull. Four farmers have started pure-bred herds in this community. Many such instances could be mentioned. We mention this work in connection with cow-testing associations because the cow-testing association gave us an opportunity through meetings and personal visits to do this. The cow-testing association with the right kind of tester does a great deal as a source of inspiration to the farmer. The Morris-Essex County Association has been strengthened a great deal since the last tester took hold of the association. He has been responsible for the association's climbing from a membership of 13 to 20.

Bull Associations. There are at present 6 bull associations in the state. Three associations have been organized this year, one in Passaic County, one in Salem County and another in Sussex County. In the valley where the Laytons Bull Association is located the writer has influenced 19 farmers to use pure-bred bulls. He has advised and helped them select their bulls. During this year 5 farmers in this valley have been started in pure-breds besides the ones started the year before, as each has purchased from one to three pure-bred females. These females were located by the specialist. There will soon be many more pure-bred females in the herds of these farmers as there is at present a demand for heifers from these communities.

Other Associations. A State Holstein-Friesian Association founded on local associations was organized this year on a 3-year basis and a full-time paid secretary hired. Under his supervision a state sale was held.

Boys' and Girls' Calf Clubs

The dairy specialists have helped the calf clubs by advising on subject matter, giving judging demonstrations and holding conferences with the local leaders and club leaders to make up programs of work for their clubs.

Dairy Schools

Two dairy schools were conducted this spring, one in Passaic County and another in Hunterdon County. These were a great success. The schools were made up of 6 lectures each, and meetings were held twice a week. The average attendance for each night was 28. Testimonials by the farmers of what the school had done for them proved to us that they were taking home ideas and putting them into practice.

Demonstrations

After the school at Paterson 2 feeding demonstrations were conducted by 2 farmers, the county agent and the writer. The farmers weighed the milk and followed the directions of the specialist. The farmers discovered that there was a big saving in mixing their own feed. One farmer made $18.50 per month more on 6 cows by mixing a ration recommended by the Agricultural College than he did by buying ready-mixed rations. A meeting was called by the county agent. After the demonstration was completed, the county agent called a meeting which was held in the barnyard of the cooperator. A blackboard was hung on the barn door, and the writer put the results on the board. There were 27 farmers present and many declared that it was a good piece of work for the dairymen of that section. These results have been used to illustrate feeding talks.

Conferences

The writer met with the county agents in conference at New Brunswick and in their own offices to make dairy extension programs of work for the different counties. Conferences were held with cow testers and local leaders to advise on methods and subject matter.

Dairy Improvement (Additional)

Aside from organization work we advised individual farmers on purchase of bulls, tuberculin testing, feeding and dairy building and equipment. We have seen our advice used and appreciated by the users. We have told farmers where they could get pure-bred bulls at reasonable figures, for when we visited a pure-bred herd and saw a good bull calf we inquired about his breeding and price and carried the information to the man who was in need of a good bull. Much tuberculin testing has taken place as the percentage of increase will show this year, as the accredited herd plan and its advantages have been explained to the farmers by the dairy specialist, the percentage of tuberculin tests shows an increase this year.

Exhibits

The dairy specialist has advocated putting good pure-bred cattle on exhibition in the form of shows to educate the farmers and also serve as an inspiration to breed better cows. He has helped select cattle for these shows. The three big shows last year were held at Trenton, Belvidere. Alcyon Park and there was also an exhibit at Farmers' Week, Trenton.

May 15, 1921, to July 1, 1921

Days spent in the field	29
Days spent in the office	12
Meetings held	14
Attendance	424
Conferences	9
Farm visits	127

Organization

Cow-Testing Associations. Two cow-testing association meetings have been held. A new tester was started in the Flemington Association. The specialist when starting the tester told a member where he could sell an excellent bull calf and he sold this calf to a man who had attended the dairy school at Clinton and who had asked the specialist to find him such a calf. A meeting was held by the Ringoes Association in Hunterdon County. The specialist outlined a dairy school, and they voted to start one July 7. The Sussex Association has added 2 members.

Bull Associations. The Laytons Association invited the farmers of Walpack Center to their annual meeting where a program was provided by the specialist. The program was an illustrated talk by Professor Regan on "How to Pick a Cow by Looking at Her," and a talk on bull associations by the writer. The testimonials of the members of the Laytons Association convinced the Walpack men that a bull association was just what they wanted, and a week later they organized. There are 6 members and 3 bulls to be used on 6 herds. Two of these bulls were selected by the specialist. The Laytons and Walpack Associations joined in a tour to visit some great pure-bred stock to get an idea to work for. They are advised by us to start in with a foundation animal or 2 and build up. Bull associations have been explained to the farmers of Warren County at several meetings.

Other Associations. A Young Men's Dairy Improvement Club was organized in Delaware Valley. There are 17 members to start with. The purpose is to cooperate in breeding up pure-bred herds of excellent quality, to learn the best methods of dairying, to make a reputation for the community through good stock. Pure-bred stock will be brought in and community testing done. The association is under a constitution. The ages of the members are from 15 to 30. This is the first of its kind to our knowledge.

Boys' and Girls' Calf Club

The specialist has attended 2 meetings with the club leader of Warren County. The club leader and specialist made a program of work and this is being carried out. The meeting at Changewater resulted in a calf club with all the members pledged to secure a pure-bred calf.

Exhibits

The Sussex County Fair has never had a good cattle exhibit. The specialist felt that there were great possibilities of a good cow show. Last year there were about 4 head of cattle. The county agent and specialist met the committee and presented to them a program by which they could have an excellent cattle show. This committee agreed to build sheds to accommodate 50 head. They have collected about $400 thus far from the bankers and business men to help build a shed and use as prize money. They plan to spend about $300 for prizes, the first prize to be $25 instead of $5. We plan to give the committee some help in selecting the animals and show them how to go about getting the animals.

Schools

There is a dairy school at Vail, Warren County, which has had 2 lectures and 4 more to be given. The first 2 meetings had an average attendance of 46. Schools have been arranged for in Hunterdon County and another in Warren County during the summer months.

REPORT OF THE FRUIT SPECIALIST

A. Freeman Mason

During the past year, the following phases of horticultural extension work were emphasized:

1. Pruning Demonstrations.
2. Spraying Demonstrations.
3. Renovation of Peach Orchards.
4. Fertilizer Demonstrations.
5. Dusting Peaches Demonstrations.
6. Grape Pruning Demonstrations.
7. Control of Peach Borers by the use of Paradichlorobenzene.
8. Laying out and Planting of Orchards.
9. Demonstration Orchards (in which all operations are supervised or carried out by specialist and county agent.)
10. Organization of Pruning and Spraying Association (Cooperatively).
11. Organization of Boys' Club Orchard Project.
12. Packing and Marketing Demonstrations.
13. Renovation of Farm Orchards.
14. Orchard Equipment Demonstrations.

While the season was very favorable to crop growth, and there were very few serious insect and disease infestations, which resulted in very heavy production, and while general price deflation and oversupply of fruit injured price, the results of the demonstrations were fairly favorable in most sections. A discussion of each topic follows:

1. *Pruning Demonstrations.* Pruning demonstrations were carried on at the following places: Henry Albertson, Burlington, Burlington County; Howard DeCou, Haddonfield, Camden County; William Ackerson, Hazlet, Monmouth County; George Martin, Eatontown, Monmouth County.

The pruning demonstrations are long-time demonstrations which are staged in an orchard for from 3 to 5 years. The results of pruning do not show up in a very striking manner in one year, the beneficial results being due to the stimulation of those portions of the tree which have become weakened through lack of light and plant-food. Regarding one demonstration in Monmouth County, George Martin writes, "as you know it is hard for a farmer to keep records, but I am sure that I did not use more than $\frac{2}{3}$ of the material (on the pruned trees) that I used on the other trees, they were much easier to spray and I know I did a more thorough job. My orchard produced 50 per cent more fruit I think than ever before." In the Henry Albertson's and Howard DeCou's orchards the pruning work was on young trees just coming into bearing. On the Stayman Winesap in the Albertson orchard heading-back to secure stocky growth was compared with trees which were not headed back. The latter bent over somewhat out of shape with fruit in some cases, while those which

PLATE 1.

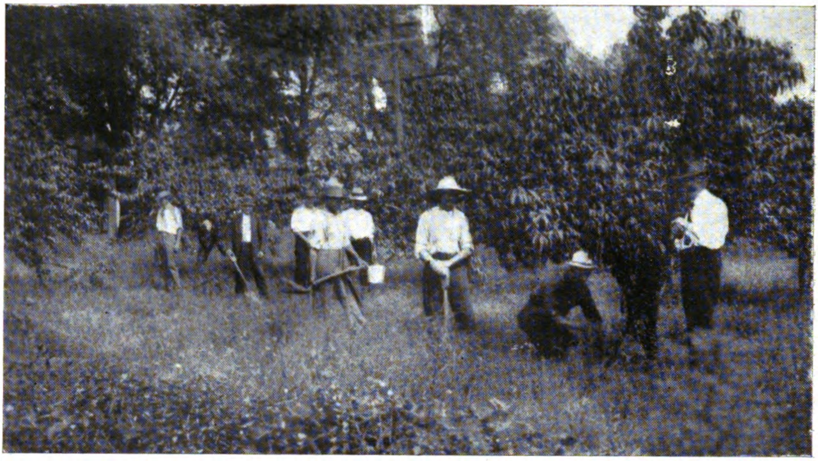

FIG. 1. APPLYING PARADICHLOROBENZENE—SEPTEMBER, 1920.

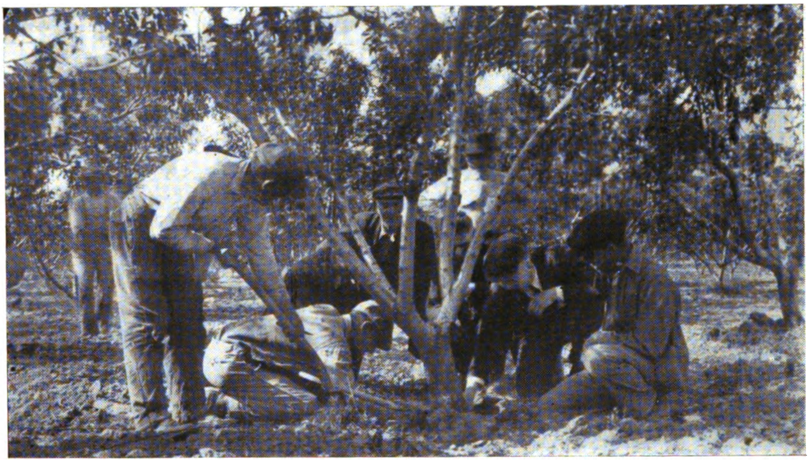

FIG. 2. WORMING THE TREATED TREES—MAY, 1921.

were cut back stood up under the heavy crop very well and are in better shape for next year. The unpruned checked trees produced heavier crops than the pruned trees, due probably to the stimulation of wood growth on the pruned trees through fairly heavy pruning. The season being unusually free from scab was favorable for the development of unusually clean crops on unpruned trees.

2. *Spraying Demonstrations.* The 6 apple-spraying demonstrations were the most important features of the work carried on by the specialist during the past season.

At Henry Ackerson's, Hazlet, the demonstration was repeated on the same block of Ben Davis trees used in 1919. The feature of this demonstration was a comparison of the value of spraying 2, 4 and 6 times to prove that spraying was responsible for the large crop increases secured in 1919 on the sprayed blocks. The results were as follows:

	No. Sprays		*Crop per Tree*	
	1919	*1920*	*1919*	*1920*
Block 1	6	6	5⅔ bbls.	5 bbls.
Block 2	2	4	3⅓ bbls.	5 bbls.
Block 3	1	2	2 bbls.	2⅛ bbls.

Seventy-five growers were convinced of the value of spraying at the demonstration meeting on October 12. The total cost for 6 sprays was $1.53 per tree.

The most important spraying demonstration was at Lester Collins, Maple Shade, Burlington County, where the codling moth was so severe that they had never been able to control it. The specialist applied the full Experiment Station schedule to the demonstration block of 330 20-year old trees, at a cost of $1.54 per tree and secured perfect control of the first brood-sting, and 73 per cent to 88½ per cent control of second brood side-sting, and matured a larger crop than on the rest of the orchard and completely changed Mr. Collins' system of spraying to one closely resembling that recommended by the Experiment Station. Forty-two fruit growers saw the results at a meeting on October 9. At the Shimp orchard at Hancock's Bridge a superb crop of York and Grimes from 86 per cent to 91 per cent perfect was produced on the demonstration block, it being the first time the orchard had had a clean crop. Three growers bought power sprayers, 4 set out orchards, and 23 are applying the full spray schedule as a result of this demonstration. Spraying demonstrations were also successful at Raymond Griggs, Cranbury, and Henry Albertson, Burlington, while one was unsuccessful at C. F. Stanger's Sons, at Glassboro, due to lack of data on the codling moth emergence.

Control of Peach Leaf Curl Demonstrated. Peach growers in Cape May County failed generally in the control of peach leaf curl, either through the use of wrong sprays or because of making the spray applications too late in the season. Eleven spraying demonstrations were planned for that county to show efficient methods in dealing with this disease. These demonstrations included both fall and spring treatments and three types of mixtures. Concentrated lime-sulfur was the material depended upon for results. The others were included as added features to the demonstration. The fall applications were made on December 8, 9, 14 and 15. Spraying conditions were somewhat unsatisfactory during this period due to high winds, but a thorough coating was given.

The spring applications were given March 1, 2, 3, 4, 5 and 9. Only one orchard, that of Mr. Taylor, at Cold Spring, was done on the latter date. Due to the earliness of the season there was a little doubt as to the effectiveness of the spring applications on one or two of the lighter warmer soils but the only place that showed any effect of the late application was the orchard of Mr. Taylor, which was done 4 hot days later than the rest.

On May 20, Prof. C. P. Close, the specialist and the county agent, J. A. Stackhouse, visited these orchards and made an inspection of the results. The location of the demonstrations and the results of the treatments as ranked by Prof. Close are given in the following table:

FARM	P. O.	Lime-Sulfur		Bordeaux		Oil	
		Fall per cent	Spring per cent	Fall per cent	Spring	Fall per cent	Spring per cent
W. H. Powell	Cape May C. H.	100	100	....	....	92	25
Chas. Howell	Dias Creek	100	100	100	100	....	....
Nubar Dionian	Erma	100	100	....	....	....	....
Allison Ludlam	Cape May C. H.	100	100	....	....	....	....
W. De Graff	Whitesboro	100	100	....	....	....	....
Joe Cohen	Woodbine	100	100	....	....	....	....
Luke Camp	Cape May C. H.	100	100	....	....	....	....
E. T. Johnson	Dennisville	100	100	....	....	....	....
Joseph Camp	Pierces	100	100	....	....	....	....
Dr. Julius Way	Cape May C. H.	100	100	....	....	....	....
Walter Taylor	Cold Spring	100	*75	....	....	....	....

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*Applied one week late due to wet weather.

3. *Renewal Pruning upon old Peach Trees.* Peach trees upon good soils that receive only a light pruning annually finally become deficient in vigor, with high heads and many weak twigs and branches.

By proper renewal pruning, however, many such trees can be made to form new tops at a desirable height and will continue to produce good crops for several years longer than otherwise is the case. The high price of nursery trees and labor during the past two seasons made it particularly worth while for growers to maintain bearing orchards as long as possible.

Peach renovation pruning demonstrations were therefore begun in 1919 and continued during the past season on the following farms: Henry Albertson, Burlington; A. J. Roberts, Moorestown; Hudson Haines, Rancocas; Julius Smith, Ellisburg, and Larson Horner, Delair. Three types of renewal pruning have been demonstrated, light heading back, medium cutting back, and severe pruning or "dehorning."

PLATE 2.

FIG. 1. A VIEW IN THE SHIMP DEMONSTRATION ORCHARD.

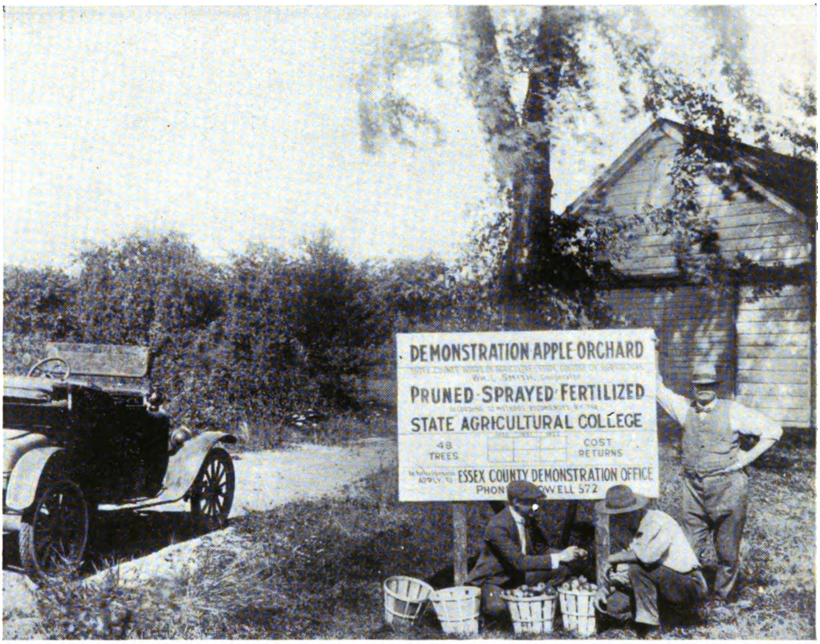
DEMONSTRATION APPLE ORCHARD
PRUNED SPRAYED FERTILIZED
STATE AGRICULTURAL COLLEGE
48 TREES
COST
RETURNS
APPLY TO
ESSEX COUNTY DEMONSTRATION OFFICE
PHON OWELL 572

FIG. 2. COUNTY AGENT FRANCIS TEACHING GROWER TO GRADE HIS APPLES PROPERLY.

The severe pruning has been most successful upon the medium growing prolific varieties like Carman, Belle and Elberta and less satisfactory on strong growing types like Smock. Where the annual pruning has been fairly heavy, it should not be necessary to practice the most severe method of renewal pruning. If the center of the trees are well opened up so as to permit new growth, the medium system of renewal pruning should be entirely satisfactory.

4. *Fertilizer Demonstrations.* Fertilizer demonstrations were carried out in the orchard of Gruver Brothers, and Kenneth Adamson of Fredon, and George Martin, Tinton Falls. At the two former places the fertilized blocks presented a marked difference in appearance from the others by the increased growth and dark green foliage.

5. *Peach Dusting Demonstrations.* Dusting for the control of peach insects and diseases has been found to be quite successful in southern New Jersey. Vineland is in the center of a peach district and yet practically no dusting work was being practiced by any of the growers. A dusting demonstration was therefore planned and carried out on the farm of Walter Ellis. The demonstration was most successful in controlling insects and diseases, but the number of trees treated was so small that the saving of time in re-filling the duster did not make up for greater expense of the dust materials, consequently the dusting showed no advantage over spraying. The demonstration was to have been repeated on a large block this year but the spring freeze destroyed the crop.

6. *Grape Pruning Demonstration.* In many sections of the state the common pruning practice followed for grapes is to run one wire about 4 feet from the ground, and wrap 3 or 4 canes about the wire in each direction from the stump. This system usually gives weak canes, poor color and susceptibility to disease. Therefore, grape pruning demonstrations were held on the farms of Larson Horner, Chews Landing, and D. H. Tice, Allendale. In both of these the old vines were changed over from the one wire system to the two wire Kniffen System. This form of pruning increased the yield at both places. A third pruning demonstration of a somewhat different type has been conducted on the John Repp Estate at Glassboro. At that point a four-arm spur renewal system has been the practice for several years and complaint was made that the bunches were running too small. It was suggested that a comparative demonstration be made of the four-arm Kniffen System of renewal in comparison with the spur system in practice. This work was undertaken first in 1919 and has been conducted since. The unusually favorable growing seasons of 1919 and 1920 has been particularly favorable to the old canes under the spur system. A very slight increase in yield was obtained from the demonstrated system of pruning in 1919, but in 1920 it was slightly less than on the old system. Clusters were greatly increased in size, however. Indications in 1921 show heavier yield on the Kniffen System.

7. *Control of Peach Borers with Paradichlorobenzene.* The Control of peach borer with paradichlorobenzene was by far the liveliest series of demonstrations carried on during the season. Before 1920 data was not available which would prove that experimental work on this question had gone far enough forward to warrant demonstration work. In the summer of 1920, however, Dr. T. J. Headlee stated that this method of control was ready for demonstration. Thirty-six demonstrations were held in 9 counties, there being between 3,000 and 4,000 trees under observations. The results are given in table 1.

The results of the treatments applied before September 15 show that both the 1 ounce and ½ ounce treatments reduced the number of borers to an average of less than 2 per tree as compared to an average of 6 in the check. The treatments applied after September 15 reduced the number of borers to an average of less than 1 per tree, while the checks showed an average of more than 8. The percentage control in the first series averaged more than 75 per cent and more than 95 per cent in the second series.

Dr. Alvah Peterson, Assistant Entomologist for the Station, has determined from his experiments that the earlier recommendation made by the Experiment Station for application between September 1 and September 15, is unsatisfactory, and is now recommending October 1 to October 15 as the date of application. Practical control, however, may be secured where application is made from September 15 to October 1, as shown by the foregoing results.

During the coming fall the demonstrations will be repeated on most of the blocks, and extended into new territory, by the addition of approximately 50 new demonstrators.

8. *Demonstration Orchards.* (Carried on by Joseph French, Assistant Fruit Specialist.) The farm orchards selected as demonstration orchards this year were unusually successful. The favorable season for growth and the general freedom from insect and disease insured a large clean crop of fruit. These orchards are all small blocks of old trees as are found on most farms, and are used to demonstrate that the farm orchard is a very important source of revenue if properly cared for, and also to try to influence the dairy farmers to diversify somewhat in their farming systems. Most of the trees had never been sprayed or pruned. The specialist, assistant specialist and county agent demonstrated to the growers the proper methods of pruning and spraying these orchards. The plan of operation laid out by the Extension Department was carried out in each, a full pruning, spraying, and fertilization program being followed. The results of the demonstrations are shown in table 2.

PLATE 3.

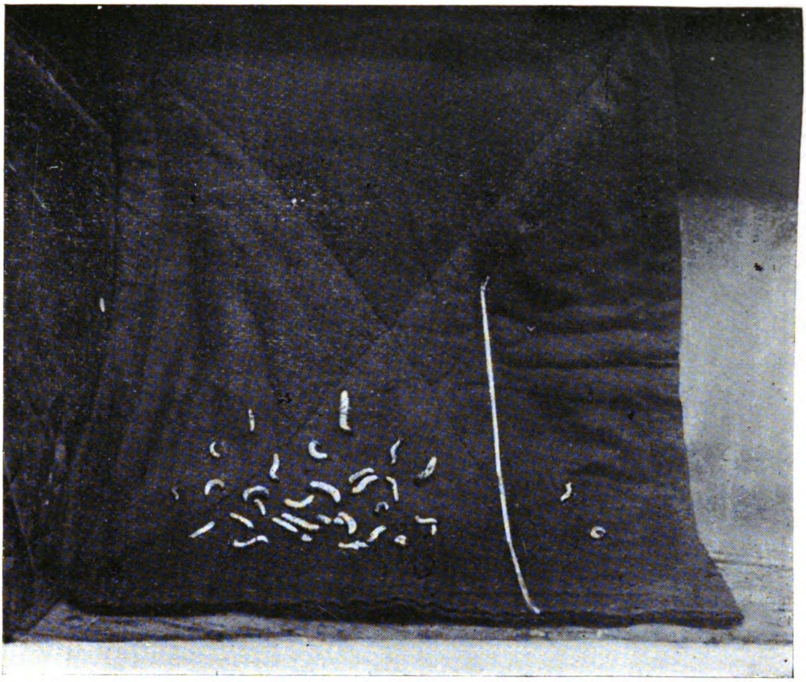

FIG. 1. RESULTS OF TREATMENT IN MONMOUTH COUNTY—31 BORERS PER TREE IN AVERAGE CHECK TREES, 2 BORERS PER TREE IN AVERAGE TREATED TREES.

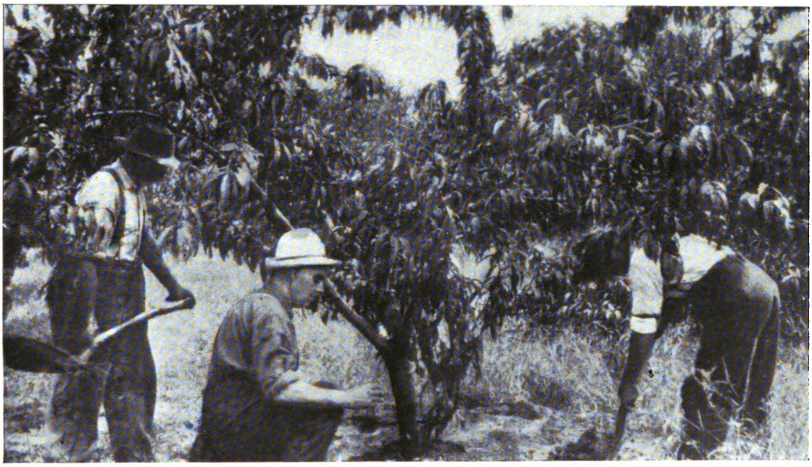

FIG. 2. THE FARMERS ARE DIVIDED INTO CREWS OF THREE MEN EACH IN LEARNING TO USE PARADICHLOROBENZENE.

Table 1

Material applied before September 15

GROWERS	P. O.	SOIL	No. Trees	Borers found 1 oz.	 ½ oz.	 Check
Sherman Borden	Beverly	sandy	15	5	4	165
Albert Harkins	Burlington	sandy	10	7	9	52
Geo. Ried	Mt. Holly	sandy loam	10	21	10	65
Herbert Cochley	Medford	clay loam	10	3	1	47
Robt. Evans	Masonville	sandy loam	10	34	18	80
Byron Roberts	Moorestown	sandy	10	12	23	35
C. C. Haines	Moorestown	gravel-loam	15	13	14	*65
Ben Lippincott	Riverton	sandy	10	14	41	*73
Minch Bros.	Bridgeton	gravel-loam	5	0	2	41
B. Gillette	Vineland	sandy loam	5	3	11	21
Jas. Bertonazzi	E. Vineland	sandy loam	7	4	11	31
A. J. Werry	N. Vineland	sandy	5	87	...	98
Locust Grove Farm	Westville	sandy	27	51	...	*175
D. G. Gaunt	Mickleton	loam	5	0	...	16
Willard Killie	Centre Square	sandy	10	7	13	*140
Jas. Kincaid	Sewell	sandy	5	3	...	17
Clark Schuster	Sewell	sandy	5	1	...	25
Ollie Burke	Swedesboro	sandy	40	0	0	80
Robt. Folwell	Mullica Hill	sandy		No records available.		
Fred Measley	Elm	sandy		No records available.		
F. E. Priestley	Elm	sandy		No records available.		
Herbert Dobbs	Haddonfield	gravel		No records available.		
Julius Smith	Ellisburg	sandy		No records available.		
S. J. Skehan	Vineland	sandy	5	38	44	50 (check estimated)
A. Weitzel	E. Vineland	sandy		Trees pulled out.		
			209	302	201	1276
Average borers per tree				1.45	1.24	6.1

*Indicates check trees wormed in fall, and no records kept, but number approximated.

Material applied after September 15

GROWERS	P. O.	SOIL	No. Trees	1 oz.	½ oz.	Check
John Cazazza	E. Vineland	gravel clay	10	0	0	81
Slack Bros.	Hammonton	sandy loam	8	2	...	65
S. F. Farrell	Hammonton	sandy loam	18	0	1	75
Joe Butterhof	W. Egg Harbor	sandy	10	6	9	*155
Joe Sahl	Upper Germania	sandy	5	6	5	13
Wm. Powell	Cape May C. H.	loam	10	2	2	58
J. C. Richdale	Phalanx	sandy	5	0	0	37
Jno. Fields	Red Bank	ironstone	5	0	4	†159
I. B. Lipman	Washington Crossing	clay	10	7	9	‡96
Forsgate Farms	Jamesburg	gravelly clay	5	2	3	4
			86	19	33	743
Average borers per tree				0.22	0.42	8.64

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* Based on 6 trees.
† Based on three trees.
‡ Based on 5 trees.

Table 2

RESULTS OF TEN DEMONSTRATION FARM ORCHARDS—**1920**

Farmer	*Post Office*	*No. trees*	*Cost*	*Returns*	*Net Profit*
Reginald Smith	Livingston	48	$192.65	$542.65	$350.00
Depew Roseberry	Belvidere	40	126.30	675.00	548.70
Milton Gibbs	Hope	91	156.62	810.00	653.38
A. E. Anderson	Upper Preakness	31	214.15	585.00	370.85
Chas. Roy	Fredon	60	146.39	558.68	412.29
Olive Wildrick	Delaware	64	190.95	400.00	209.05
Sam Buser	N. Haledon	19	80.40	375.00	294.60
Jas. Black	Hainesville	60	193.05	750.00	556.95
Wm. Farver	Vernon	32	84.82	155.89	71.07
C. B. Herold	Ridgewood Park	40	241.40	540.00	298.60
Farm					
10 orchards		485 trees	$1,626.73 handling costs	$5,392.22 gross returns	$3,765.49 net profits

Average cost per tree $3.35
Average gross return per tree $11.11
Average net return per tree $7.76

9. *Pruning and Spraying Ring.* In the northern part of the state many farms have good orchards of from 50 to 100 or 200 trees which are not being cared for because they are too small to warrant the purchase of power equipment. To assist this situation the first pruning and spraying ring in the state was started at Sussex in 1920, and has been operating since under the name of The Sussex Cooperative Fruit Growers' Association. A man was employed to direct the pruning and spraying for the 9 members of the association. Two more have been started in 1921, one in Morris County in charge of William McIntyre and the other in Essex County where William Fund was doing the work with a privately owned sprayer.

10. *Boys' Club Orchards.* A bearing orchard of apples which had not been pruned and sprayed for several years was offered for boys' and girls' club work and the fruit specialist was requested to plan the project. This was done in consultation with Prof. Hulbert, the state club leader, the county club agent, and the farm demonstration agent, and the boys were successful in the work of spraying and pruning the trees. It was found, however, that the work was too heavy for boys under the vocational school age.

11. *Apple Packing.* Meetings were held in Warren, Somerset, Sussex and Middlesex Counties where the specialist gave practical illustrations of proper methods of grading and packing apples.

12. *Miscellaneous Work.* In addition to the regular projects the specialist has been called upon to assist in planning of orchards, selection of spraying equipment, and giving assistance and advice in connection with various orchard problems.

REPORT OF EXTENSION SPECIALIST IN NUTRITION

Florence Powdermaker

Nutrition work was organized under a specialist on September 1, 1920. This report, therefore, covers 10 months' work.

Approximately 20 per cent of our child population—both rural and urban—have been found to be undernourished, according to commonly accepted standards. Among adults some of the many ills due to improper food selection are so frequently observed that they are considered a commonplace occurrence, and the need for intelligent direction of the diet is not realized until the facts are put before them.

To meet these needs general talks on the relation of food to health were given at grange meetings, farmers' institutes, clubs, etc. Food for children was also discussed as well as the facts and popular fancies on nutrition. One hundred and ten meetings were addressed with a total attendance of 4,226.

The work has also been organized under projects in order that demonstrations might be carried on to show what right feeding can accomplish and the help that can be given in meal planning. The work with the undernourished children is being carried on by the home demonstration agents and specialist with the help of local leaders in some communities and also in cooperation with the Red Cross, the N. J. Tuberculosis Association, etc. Nine demonstrations are being carried on in 5 counties and the one city (Paterson) with a total of 764 children. In some of these, "graduation exercises" have already been held. In Sussex County, for example, 15 out of 30 children have come up to normal since February and in Paterson 14 out of 34 since January. Four more demonstrations are definitely arranged for the fall.

The meal planning project aims to give a thorough working knowledge of nutrition to the average housewife. It covers questions of digestion and assimilation, the constituents of foods, the nutritive value, cost and preparation of the different foods and the bringing together of this information with the planning of meals suited to all members of the family. The use of the fireless cooker in the planning of meals is also discussed. Seventeen such demonstrations are being carried on in 6 counties and in Paterson, and 8 have been arranged for, 3 of which are in 2 other counties.

Especially worthwhile has been the work with young mothers which is just starting. The specialist or home demonstration agent meets 3 times groups of young women and discusses with them the food for the mother during pregnancy and nursing and the food for the child immediately after weaning and up to 6 years. The project has been completed in one community and others are planning for the work. After the meetings under all the projects, the specialist discusses any individual problems in nutrition that may come up. It is believed that this personal work is perhaps the most valuable part.

Talks on the value and organization of the school lunch have been given in counties in which there is no club agent or in cooperation with the agent. After one talk in Camden County a school lunch was started which served cocoa, milk and a hot dish to an average of 33 children each day. Previously the children usually ate their cold lunch running around the school yard. The work was started without funds by a committee of 10, one member of which loaned the money for the first supplies. Four school lunches were started in another county.

A food project has been worked out for the boys' and girls' clubs with a program of work covering 2 years and including the preparation, nutritive value, cost, serving and care and preservation of food. Ten such clubs have been organized. During Field Week one team gave, for the first time, demonstrations showing the preparation of a dish from canned vegetables and another prepared and served a meal.

A series of talks on nutrition and the methods of getting the information over to the housewife and to children was given to 3 groups of public health nurses of the State of New Jersey and of several communities. Two groups met 6 times with an average attendance of 58. The third group was given two talks and the attendance at each was 75.

REPORT OF EXTENSION SPECIALIST IN CLOTHING

Mrs. Catharine H. Griebel

The clothing project, as carried on in New Jersey from July, 1920, to July, 1921, shows a great improvement over the previous year's work. The different phases of the project which are being offered to the women are:

Permanent Pattern No. 1
Dress Design No. 1
Dress Forms
Permanent Pattern No. 2
Dress Design No. 2
Millinery

These are reported by all counties in a very definite way so that the specialist's annual report gives an accurate account of the work as a whole. Such problems of clothing as health and posture, design, color and appropriateness are presented to the women by means of illustrated lectures, style shows, etc. This is usually done by the specialist.

During the year the specialist has taught 126 all-day groups. She has given 127 talks—attendance, 5,190 people. Conferences in the field, 10.

Organization

In order that the specialist might strengthen the organization in the counties, she visited each home demonstration agent in December, 1920, and together they set a goal for 1921 as follows:

1. To secure a county clothing project leader.
2. To secure a project leader in every community interested in clothing work.
3. To endeavor to carry on all clothing work possible by local leaders or with assistance of local leaders.
4. To establish a few home demonstrations.

During the six months which have passed the results have been most gratifying.

Attainment of the Four 1921 Goals

County	Communities	*1*	*2*	*3*	*4*
Bergen	19	yes	yes	yes	yes
Mercer	13	yes	yes	yes	yes
Middlesex	16	yes	yes	yes	yes
Sussex	14	yes	yes	yes	yes
Monmouth	10	no	yes	yes	yes
Morris	17	yes	10	yes	yes
Essex	9	Report not complete			
Passaic	13	no	3	yes	yes
Paterson	12	yes	5	yes	yes

123 communities doing definite clothing work

Counties without home demonstration agents doing clothing work:

Gloucester County	County clothing project leader. 7 communities doing clothing work. Leaders.
Camden County	County clothing project leader. Organization project leader. 7 communities doing clothing work. Leaders.
Hunterdon County	Organization not completed but all doing clothing work.
Somerset County	
Warren County	
Salem County	
Cumberland County	
Burlington County	

The specialist has met with wonderful cooperation in counties where there are no home demonstration agents, and some remarkable work has been done. In a rural district in Somerset County a group of 6 leaders in permanent pattern No. 1 ordered 30 additional patterns and to date have reported 10 women for whom patterns have been altered and 34 dresses and 4 waists made. In Burlington County a group of 8 women have reported 19 additional dress forms made for neighbors. Gloucester County women met at three central points for group work and will report in July on "follow-up" work.

Leaders

Specialist held 4 training groups at the State College for home demonstration agents as follows:

September	Millinery
January	Permanent Pattern No. 2
March	Dress Design No. 1
March	Dress Design No. 2

The specialist has also conducted 22 leader groups in the counties. For these groups one woman from each community has come to a central place for instruction in the various phases of the clothing project. She then assists the home demonstration agent in her own community. Two hundred and eighty such leaders have been trained.

Millinery

The specialist has conducted 9 leader groups—84 leaders trained. Millinery leaders conducted all groups in technique in Bergen County and assisted home demonstration agent in groups making hats. Essex, Mercer, Monmouth, Passaic and City of Paterson report leaders assisting. Middlesex reports leaders assisting at all groups and one leader who conducted alone 4 groups numbering 30 women.

1,158 hats were made in 8 counties, saving $6,735.47

Not included in this, 10 home demonstrators report for a period of 3 months as follows:

117 hats were made at a saving of $561.50
and 8 women were helped.

"Made 20 hats. Did not charge for them."
"Helped 6 people besides assisting in class."
"During March, April and May, I have made 38 hats valued at $350.00; remodelled 20 hats with a saving of $50.00."
Bergen County

Dress Forms

Ten counties have carried on work in dress forms and report as follows in regard to leaders:

Middlesex County	1 conducted group alone, assistants in all groups.
Bergen County	3 conducted groups alone, assistants in all groups.
Essex County	Assistants in all groups.
Mercer County	4 conducted groups alone, assistants in all groups.
Passaic County	1 conducted group alone, assistants in all groups.
Sussex County	Assistants in all groups.
City of Paterson	Assistants in all groups.
Burlington County	4 conducted groups alone.

508 forms made. Saving $6,361.34

"Saving" was computed on difference between cost of material and that of cheapest adjustable form ($17.00).

For a period of 3 months 25 home demonstrators report as follows: 92 garments made or remodelled at a saving of $153.65. Six helped others to make dress forms. Saving of time varies from 2 hours to 2 days of dressmaker's time.

"Have helped 4 women to make dress forms."
Bergen County
"Black satin dress on form, cost $11.00, store value $35.00."
Essex County.
"I find the dress form particularly useful for remodelling."
Passaic County.
"Could not get along without it."
City of Paterson
"Seven summer dresses made in March, saving $26.60."
Middlesex County

Permanent Pattern No. 1

Since July, 1920, 1,547 permanent patterns have been made. All counties report leaders assisting in all groups and many have conducted groups alone.

45 home demonstrators for permanent pattern No. 1.
These report for three months:
  199 garments made without fittings.
  19 helped others to make patterns.

Permanent pattern No. 1 is considered a saving of time and nervous energy, but home demonstrators report money savings in some instances.

"Gingham dress cut and made in 5 hours, cost $.88, saved $4.50."	City of Paterson
"Three gingham dresses completely finished in 4 days. Tried on when finished."	Bergen County.
"Saved in time, one day."	Middlesex County.
"I can make a dress without trying it on and that saves a lot of *time* and *trouble* when you sew for yourself."	Middlesex County.
"Gingham dress cost $1.10—cut and finished in 5 hours, worth $9.00."	Paterson

Dress Design No. 1 was introduced as a help to those women who had made permanent pattern No. 1 in the way of suggestions for use of pattern. This is a new phase and to date 21 groups have been conducted.

Permanent pattern No. 2 is also new. Five leader groups have been conducted by specialist in the counties requesting this work.

Junior Clothing Work

Since January, 1921, the specialist has been assisting with this work. Four kits of illustrative material have been prepared under her supervision for use in the field. These garments will serve as models and will, we hope, raise the standard for our juniors. A score card has been prepared together with several sheets of explanation of same.

In January and again in June specialist put on style show assisted by club girls and their leaders and in February she took a two-day trip covering a good part of Ocean County. She gave 6 talks in the 2 days to groups of girls, leaders and teachers.

REPORT OF THE DEPARTMENT OF AGRONOMY AND AGRICULTURAL ECONOMICS

Department of Agronomy and Agricultural Economics

*FRANK APP, PH.D., *Chief of Department.*

†GEORGE W. MUSGRAVE, M.S.A., *Acting Agronomist in Charge.*

ALLEN G. WALLER, M.SC., *Specialist in Farm Management Research.*

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*On leave of absence, October 1, 1920.
†On College staff.

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Report of the Department of Agronomy and Agricultural Economics

GEORGE W. MUSGRAVE

REPORT OF WORK IN AGRONOMY

Testing of Strains of Alfalfa

The work of testing the strains of alfalfa suited to the varying conditions of soil and climate which are found in the state has been continued with further data indicating the superiority of the Kansas and other Northwestern seed for the conditions as found in this state. This recommended seed is being made available to the farmers of the state through the New Jersey Alfalfa Association, of which the chief of the department was secretary until January, 1921, at which time the extension specialist in agronomy was made secretary. This seed is placed in the hands of the farmers at wholesale prices after being carefully inspected by representatives of the department. Further work along this line is to be done to determine the proportion of various strains for the local conditions of the state.

Crop Failures Following Alfalfa

This project on which results have been given in previous reports has been continued and the data in table 1 obtained. While no outstanding results have been obtained, it is apparent from a study of the average results that the plots which received phosphorus have given the highest yields, which data are in agreement with other data secured in the state.

Table 1

Yield of Potatoes on Alfalfa Sod

Farm of D. D. Solomon, Freehold, N. J.

Variety of potatoes used, New York Giants, raised by Edmund Edwards.

Plot plowed April 19, 1920, planted April 22, 1920, dug October 8, 1920.

Row	TREATMENT	Amount Used per Plot	Yield per Acre	Per cent Small	Per cent Scabby
		lbs.	bbl.		
1	100 lbs. 4-8-4 Check	75	88.73	13	.....
2	100 lbs. 4-8-4 plus 20 lbs. nitrate of soda	120	64.29	19	.....
3	100 lbs. 4-8-4 plus 50 lbs. acid phosphate	145	102.51	5	.....
4	100 lbs. 4-8-4 plus 20 lbs. muriate of potash	100	70.32	14	.....
5	100 lbs. 4-8-4 plus 20 lbs. sulfur	110	90.95	4	3
6	100 lbs. 4-8-4 Check	75	93.33	10	.....
7	100 lbs. 4-8-4 plus 10 lbs. sulfur	95	99.00	7	4
8	50 lbs. nitrate of soda	50	41.40	24	.....
9	100 lbs. acid phosphate	100	73.43	10	.....
10	25 lbs. muriate of potash	25	57.00	10	1
11	100 lbs 4-8-4 Check	75	106.80	20	.....
12	Nothing	......	80.88	19	5
13	100 lbs. 4-8-4 plus 20 lbs. nitrate of soda	115	63.67	18	2
14	100 lbs. 4-8-4 plus 50 lbs. acid phosphate	145	102.00	23	.....
15	100 lbs. 4-8-4 plus 20 lbs. muriate of potash	120	84.35	11	1
16	100 lbs. 4-8-4 Check	75	96.00	16	3
17	100 lbs. 4-8-4 plus 10 lbs. nitrate of soda	110	75.00	14	3
18	100 lbs. 4-8-4 plus 25 lbs. acid phosphate	125	119.40	13	3
19	100 lbs. 4-8-4 plus 10 lbs. muriate of potash	110	83.64	3	19
20	100 lbs. 4-8-4 plus 100 lbs. acid phosphate	160	100.20	10	1
21	100 lbs. 4-8-4 Check	75	106.08	23	6
22	Nothing	......	....	38	8

	Average Yield	Marketable Yield	
	bbl.	per cent	bbl.
Check	98	83⅗	81.93
Check plus acid phosphate	108	86⅓	93.24
Check plus muriate of potash	79	90⅔	71.63
Check plus nitrate of soda	68	83	56.44

Size of Potato Seed-Piece

Work has been continued on the size of potato seed-piece as related to yield on two quite different soils, one of which was a very good potato soil and the other a rather poor potato soil. The yields from the better soil are given in table 2.

Outline of Test Plots in Experiment on Size of Potato Seed-Piece, on the Farm of Clifford D. Stults, Cranbury, N. J.

Plot 1	Check.		(Certified Green Mountains.)
Plot 2		½ oz. New York Giants.	
Plot 3		½ oz. Green Mountains.	
Plot 4	Check.		
Plot 5		1 oz. Green Mountains.	
Plot 6		1 oz. New York Giants.	
Plot 7	Check.		
Plot 8		1½ oz. Giants.	
Plot 9		1½ oz. Green Mountains.	
Plot 10	Check.		
Plot 11		2 oz. Green Mountains.	
Plot 12		2 oz. Giants.	
Plot 13	Check.		
Plot 14		2½ oz. Giants.	
Plot 15		2½ oz. Green Mountains.	

Length of Rows. The length of rows varies somewhat, but all of them reach from the end of field nearest the road to a point opposite the shed in the field with the exception of plot 3, which does not begin until a point 35 feet from the road.

Fertilizers. 1800 pounds of 4-8-6 per acre.

Table 2

Results of Experiment on Size of Potato Seed-Piece at Cranbury, N. J.

Size of Seed-Piece	Average Yield	Average Number of Hills	Yield per Hill
	lbs.		lbs.
½ oz.	361.75	270.00	1.340
1 oz.	521.50	260.62	2.000
1½ oz.	530.25	247.50	2.140
2 oz.	528.00	238.12	2.217
2½ oz.	527.00	226.87	2.323

Average yield per acre of all plots, 343.31 bu.

The data indicate an increase in yield up to and including a 1½-ounce piece. The average yield per acre of all plots was 343.34 bushels, indicating a very favorable soil on which the crop was grown. From the 1½-ounce point, increase in size of seed-piece did not bring a corresponding increase in yield on soil of this character. The average size of seed-piece which is used by the farmers of the state is about ¾ ounce, as has been indicated by data secured in farm management surveys.

In this experiment the work was carried on with the cooperation of one of the potato growers and the seed was planted with a planter. All operations were similar to those usually practiced in the potato section. In planting the seed with the regular potato planter, more pieces were dropped of the smaller size than of the larger size, and the spacing of the plants is indicated under the heading "Average Number of Hills."

The yield increased from 1.34 pounds per hill to 2.323 pounds per hill, as the size of seed-piece was increased from ½ ounce to 2½ ounces. Further work is to be done using the various sizes of seed-piece at varying planting distances.

On the somewhat poorer potato soil the total yields have increased rather uniformly as the size of seed-piece has been increased, as indicated by the data from the experiment on the College Farm.

Arrangement of Plots in Test of Size of Potato Seed-Piece on the College Farm

Plot 1	Check.	
Plot 2		½ oz. Giants.
Plot 3		½ oz. Green Mountains.
Plot 4		½ oz. Late-Crop Cobblers.
Plot 5	Check.	
Plot 6		1 oz. Giants.
Plot 7		1 oz. Green Mountains.
Plot 8		1 oz. Late-Crop Cobblers.
Plot 9	Check.	
Plot 10		1½ oz. Giants.
Plot 11		1½ oz. Green Mountains.
Plot 12		1½ oz. Late-Crop Cobblers.
Plot 13	Check.	
Plot 14		2 oz. Giants.
Plot 15		2 oz. Green Mountains.
Plot 16		2 oz. Late-Crop Cobblers. (Whole potatoes.)
Plot 17	Check.	
Plot 18		2½ oz. Giants.
Plot 19		2½ oz. Green Mountains.
Plot 20		½ oz. Whole Late-Crop Cobblers.
Plot 21		1 oz. Whole Late-Crop Cobblers.
Plot 22	Check.	

Plots consist of one row each arranged according to diagram in the file of the Department of Agronomy. Planted April 24, 1920. Ground somewhat wet. Feltilizer used: 1600 pounds 4-8-5 (approximately), home-mixed. Seed-pieces hand-dropped 15 by 33 inches apart in all plots.

The data show a continual and rather uniform increase in total yield as the size of seed-piece is increased. After subtracting for the seed used, the net yield also increases rather uniformly from the ½-ounce to the 2½-ounce seed-piece. With the late-crop seed, a smaller size of seed-piece has given equivalent results to the larger size of the mature northern-grown seed. The work is to be continued.

Table 3

Average Yields per Acre (All Varieties) in Test of Size of Potato Seed-Pieces at the College Farm

Size of Piece	Total Yield		Less Seed		Net Yield	
	lbs.	bu.	lbs.	bu.	lbs.	bu.
½ ounce	4110	68½	480	8	3630	60½
1 ounce	4650	77½	960	16	3690	61½
1½ ounce	5910	98½	1440	24	4470	74½
2 ounce	6390	106½	1920	32	4470	74½
2½ ounce	7389	123	2400	40	4980	83
Checks	3900	65	720	12	3180	53
½ oz. whole late-crop	4380	73	480	8	3900	65
1 oz. whole late-crop	7260	121	960	16	6300	105

Potato Variety Testing

Under the conditions found in the northern part of the state, the testing of potato varieties was begun and the results given in table 4 were obtained. This work is to be continued as soon as the personnel of the department permits.

Plot Arrangement in Potato Variety Test on the Farm of Herbert Francisco, Caldwell, N. J.

Plot 1	Check.	
Plot 2	Green Mountains	A. G. Smith, Williamstown, N. Y.
Plot 3	Green Mountains	Lyman Pierce, Marathon, N. Y.
Plot 4	Check.	
Plot 5	Green Mountains	Monmouth County Farmers' Exchange, Freehold, N. J.
Plot 6	Green Mountains	Mark Rupley, Moravia, N. Y.
Plot 7	Check.	
Plot 8	Cobblers	Minch Bros., Bridgeton, N. J. (Marble-size planted whole.)
Plot 9	Cobblers	Eastern Shore Produce Exchange, Va.
Plot 10	Check.	
Plot 11	Rural New Yorkers	Edw. F. Dibble, Honeoye Falls, N. Y.
Plot 12	Russets	Edw. F. Dibble, Honeoye Falls. N. Y.
Plot 13	Check.	
Plot 14	Giants	George W. White, Washington County Seed Association, Cassayuna, N. Y.
Plot 15	Giants	Wm. McClay, Greenwich, N. Y.
Plot 16	Check.	
Plot 17	Giants	Monmouth County Farmers' Exchange, Freehold, N. J.
Plot 18	Norcross	F. G. Carter, Marathon, N. Y.
Plot 19	Check.	

Row 1 begins at lower side of field adjoining fence, and runs the full width of the field, 286 feet.

Table 4

Record of Yields of Potato Variety Test Plots Harvested September 3, 1920

Plot Number	Yield lbs.
1	96.00
2	*
3	232.00
4	78.50
5	148.00
6	225.50
7	52.00
8	160.00
9	333.00
10	86.50
11	166.00
12	95.00
13	122.25
14	156.75
15	208.00
16	69.00
17	132.00
18	229.50
19	76.50

* Results omitted because of apparent error in weight.

Average Yields

Checks .... 82.96 lbs., average on 7 plots = $69.13^1/_3$ bu. per acre.
Green Mountains ...201.8 lbs., average on 3 plots = $168.16^2/_3$ bu. per acre.
Irish Cobblers ......246.5 lbs., average on 2 plots = 205.41 bu. per acre.
Giants ....165.58 lbs., average on 3 plots = 137.98 bu. per acre.
Blue Sprouts ....130.5 lbs., average on 2 plots = 108.75 bu. per acre.
Plots consist of 1 row 282 feet in length.
Distance between rows 37 inches.
Area of plots equals 0.0199 acre.

Selection of Superior Strains of Potatoes

Selection of superior strains of potatoes was begun on two of the larger potato farms of the state. On each of these farms 100 hills were selected from a field in which 500 of the best were dug and inspected before selections were made. Characteristics of the vine and tuber of each of the hills have been recorded and considerable data on

PLATE 1

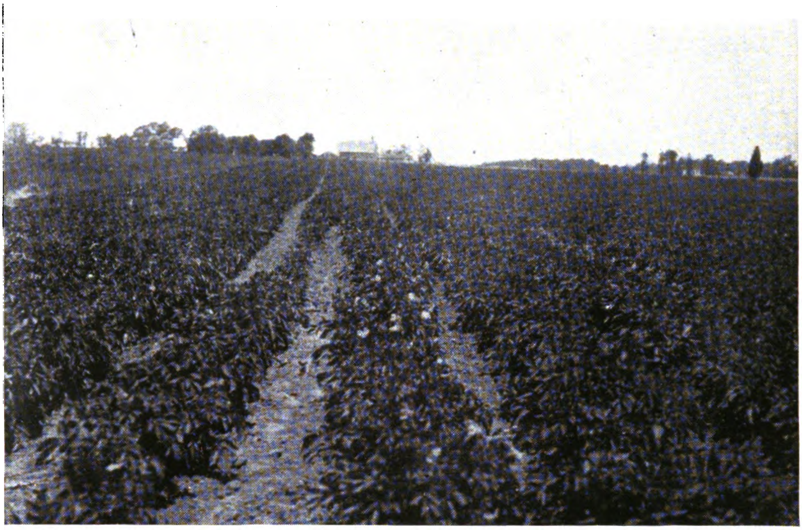

FIG. 1. VARIATION IN TIME OF BLOSSOMING AS WELL AS SIZE AND VIGOR OF PLANTS FROM HILL SELECTIONS (16 PLANTS IN EACH HILL UNIT).

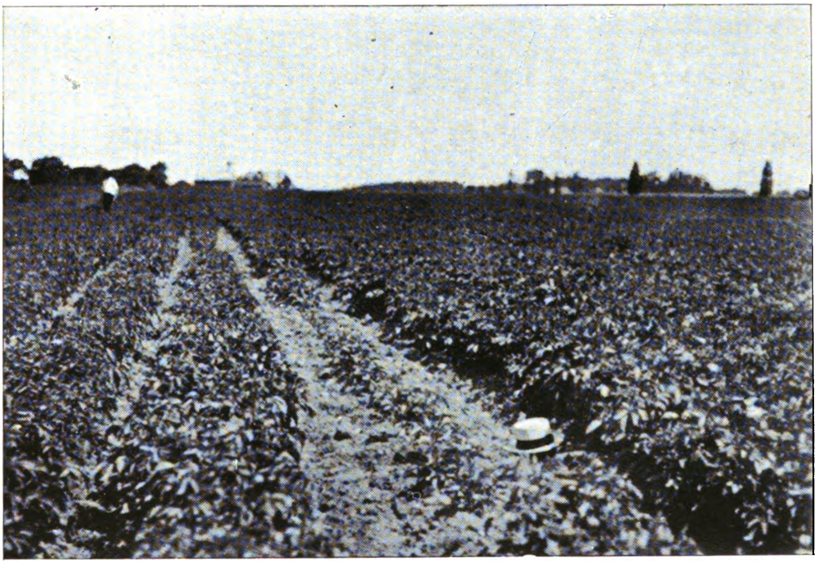

FIG. 2. EXTREMES OF TYPES IN HILL UNITS SELECTED IN THE FALL OF 1920 (16 HILLS COMPOSE EACH UNIT).

the characteristics on the above-ground parts of high-yielding hills have been obtained. Tubers from each of these hills have been planted this year. Each tuber was cut in 4 pieces and planted in order, and each tuber unit and hill unit indicated in its place in the field. The plots at the present time are in good condition and considerable differences are apparent in the various tuber and hill units (Plate 1). The work will be continued for 4 or 5 years, or until definite results are obtained.

Development of an Area of Ground for Experimental Plots

The development of an area of ground for experimental plots has been begun by the department and 7 acres of rather uniform soil has been made available for this purpose. The ground has been surveyed and plots have been laid out, giving a total of 102 1-20-acre plots. This ground is to be devoted to corn breeding, inbreeding by selection in self-fertilized lines, variety testing of wheat and oats, the growing of timothy and clover, and variety studies of soybeans, cowpeas, and other farm crops, as well as the trial of crops new to the state, such as kudzu, several of the Australian clovers, etc. The plots will also include most of the native and common grasses and clovers, as well as small plots of the miscellaneous annuals for educational purposes. During the present year, the entire area is being put in a cultivated crop in preparation for the beginning of experimental work the coming year.

Hydrogen-ion concentration tests of the entire area indicate rather remarkable uniformity from this standpoint, and the ground appears well suited to the purpose of experimental work.

Assemblage of the Best Varieties and Strains of Corn

For the corn-breeding project, there has been assembled over 50 of the leading varieties and strains of corn grown in the state. The results of the demonstration tests in various parts of the state, and of the experience of the growers and of the county agents has been used in making these selections. There are also included in the project several of the more important varieties and strains from the adjoining states, as well as the leading varieties of the Corn Belt states. These are being grown during the present year and each will be self-fertilized and the seed used during the coming year in the breeding project. Careful records are being obtained as to the characteristics of each, its previous history and performance, as well as its performance under the breeding project. The total number will be brought up to approximately 100 during the present year.

Introduction of Certain New Crops for the State

The introduction of certain new crops for the state has been begun through the cooperation of the extension specialist in agronomy. This work is to be continued and enlarged as ground and equipment and personnel become available for the work.

REPORT OF WORK IN AGRICULTURAL ECONOMICS

ALLEN G. WALLER

Investigational work on the cost of producing farm products and the best farm practices has been continued during the past year in cooperation with the United States Department of Agriculture.

Cost of Producing Can-House Tomatoes

This project was started in 1918, and for 3 successive years data have been obtained, showing the cost of growing the crop over a period of years which included widely different seasonal risks and corresponding differences in the crop yields. The average yields obtained for the 3 years were as follows:

	1918	1919	1920
Tons per acre sold	6.23	2.09	5.74
Tons per acre not sold	0.60	....	0.25
Total yield per acre (tons)	6.83	2.09	6.07

It will be seen that of the 3 years, 1918 and 1920 were favorable seasons for the crop, with the 1919 season a very unfavorable one, but 2.09 tons per acre being obtained. The significant facts shown by this table are:

1. The wastage in years of high yields due to the inability of the canners to handle the crop expeditiously and also partly to the farmers' inability either through lack of sufficient labor and machinery, or poor management.

2. The crop risk or hazard that the farmer is contending with. The amounts of materials and labor are relatively the same from year to year, except the harvest item which, of course, is reflected in the yield. The data for 1918, 1919 and 1920 are considered to have covered rather completely the differences in seasons and conditions which affect costs over a period of years. Therefore, with complete data in quantities of materials and labor required, the results of this project are now in print as Bulletin 353 (Farm Management Bulletin 5). The cost of the crop from year to year can easily be estimated very closely by using the current prices for materials and labor.

Table 1

Cost of Producing Can-House Tomatoes in New Jersey

ITEMS	1918		1919		1920		3-Year Average	
Number of Farms	†280		205		205		690	
Acres Grown	2616.25		1966.3		2040.25		2207.6	
	Amount	Cost	Amount	Cost	Amount	Cost	Amount	Cost
Seed (oz.)	2.176	$2.87	2.496	$0.60	2.4	$0.61	2.40	$1.50
Plants (number)	893	......	1320	3.63	1338	3.26	1173.14	2.08
Baskets (number) ...	37	5.06	19	2.59	23	3.13	26.94	3.73
Cover crop (lbs.)	29	0.99	50.4	1.68	28.2	1.04	35.40	1.21
Fertilizer (lbs.)	801	14.62	891	20.08	859	18.71	884.42	17.50
Manure (tons)	7.23	14.29	6.0	15.07	7.74	16.28	7.32	15.14
Lime (lbs.)	174	0.20	700	1.60	480	0.66	420.00	0.76
Spray material	......	0.91	......	0.78	......	0.81	....	0.84
Man labor (hrs.)	142	38.87	101.8	33.59	128.39	49.10	125.99	40.45
Horse labor (hrs.) ..	100	20.00	69.5	16.38	80.68	16.33	85.03	17.80
Machine labor (hrs.)..	100	6.17	69.5	5.18	80.68	5.65	85.03	5.72
Truck labor (hrs.)....	2.93	4.13	2.2	3.22	3.48	5.21	2.86	4.20
Tractor labor (hrs.)..	.08	0.12	0.2	0.31	.65	0.98	.30	0.44
Land rental	......	9.27	......	10.24	......	11.30	....	10.18
Interest on money (6%)	......	1.76	......	1.74	......	2.00	....	1.83
*Miscellaneous	......	......	......	1.72	......	0.53	....	0.69
Cost per acre		‡$119.26		$118.41		$135.62		$124.06
Cost per ton sold		19.13		56.56		23.64		25.58
Yield per acre sold...		6.23		2.09		5.74		4.85
Yield grown per acre..		6.83		2.09		6.07		5.19
Cost of harvesting ...		$6.24		$8.85		$6.95		$6.96

*Insurance, hot-bed materials, use of auto in getting plants, hauling hired.

†Includes 40 Cape May County farms.

‡Omitting supervision charge of 10 per cent which was not made in 1919 and 1920.

Table 1 shows in detail the costs for the 3 years; but the average cost for all the producers includes some growers who are producing the crop at a high cost due to inefficient methods of handling labor, machinery, crop practice or conditions which do not warrant attempting to grow the crop. Hence the average cost for all the growers, efficient and inefficient, should not be the basis of consideration when attempting to arrive at what is a fair price.

In all cost of production work the aim should be to determine not only the cost in dollars and cents, but the factors in farm practice which make the most economical and efficient methods of production. From the results of the investigation in the cost of producing can-house tomatoes, the following factors have been found materially to affect the efficiency in producing the crop.

1. The average amount of fertilizer applied was 844 pounds per acre.
2. The average amount of manure applied was 7.23 tons per acre.
3. Cover crops were used by some of the growers, consisting largely of rye, wheat and vetch or clover.
4. The yields did not vary appreciably whether the individual acreage was small or large.
5. The acre costs were largest on the smaller acreages.
6. The ton costs were higher than the average cost of production on farms having 8 acres or less, but lower on the farms with more than 8.
7. The rate of fertilizer application was less than the average on farms with 8 acres or less and heavier than average on the larger acreages.
8. The rate of manure application was heavier than the average on farms with 8 acres or less, and lighter than average on the larger acreages.
9. The hours of man and horse labor required to produce a ton of tomatoes were highest on the farms with 8 acres or less.
10. Labor and materials were used most efficiently in producing can-house tomatoes on farm areas of 8.1 acres or more.
11. Over half of the farmers were growing 8 acres or less per farm, with a total acreage 25 to 30 per cent of the average for all farms, and a corresponding per cent of total production in tons.
12. Heavier applications of fertilizer did not materially reduce the cost per ton, but did increase the number of tons per acre, resulting in a larger acre profit, provided the cost of production was not above the price which the farmer received.
13. The application of manure, dollar for dollar, did not bring so large a return as the application of fertilizers.
14. In 1918, 150 pounds of fertilizers with a cover crop took the place of 19 tons of manure; in 1919, 526 pounds of fertilizer with a cover crop took the place of 21 tons of manure; whereas in 1920, 142 pounds of fertilizer with a cover crop took the place of 20 tons of manure.
15. Farmers who used cover crops produced larger yields per acre.
16. A top-dressing of nitrate of soda did not appear to increase the yield to any appreciable extent.
17. Spotting, as far as it was practiced on these farms, did not appear to increase the yield materially. However, it is possible that the full effect of spotting did not show up, inasmuch as most of the growers did not spot their entire crop.
18. Early planting materially increased yields.
19. It appears that 7 cultivations was the maximum which were made with profit throughout the 3-year period.
20. Lime did not increase yields.

Cost of Onion Production, 1920

At the request of the Cedarville Onion Growers' Association and the Cumberland County Board of Agriculture, figures were obtained to determine the cost of producing onions in the Cumberland County section. The year 1920 was a disastrous one financially for the onion growers of South Jersey, as there was a large crop and the prices received were very low. Records were obtained on 16 farms growing a total acreage of 121¾ acres of onions. The yield sold per acre last year was 179.7 hampers, but the prices were so discouraging that there was an average of 62 hampers per acre which were not sold, but either simply plowed under or allowed to rot after harvesting. It cost $279.28 an acre to produce and market the 179.7 hampers which were sold, or $1.55 per hamper. Had the entire crop been marketed,

Table 2

Cost of Growing Onions in Cumberland County, New Jersey, 1920 Results from 16 Farms, With a Total of 121¾ Acres of Onions

Item	Amount	Cost
Sets	8.56 bu.	$43.02
Fertilizer	1276 lbs.	37.79
Cover-crop seed		2.95
Manure	9.4 tons	36.76
Hampers	180	32.03
Operator's time	48.4 hrs.	20.86
Hired labor (month)	29.0 hrs.	10.82
Hired labor (day)	162.8 hrs.	52.62
Horse labor	83.25 hrs.	17.61
Horse machine hours	83.25 hrs.	5.83
Tractor		0.01
Truck	1.8 hrs.	2.69
Rental on land used by crop		12.05
Insurance		0.11
Interest		4.13

Total cost per acre	$279.28
Cost per hamper sold	1.55
Additional cost for harvesting unsold onions	14.70
Acre cost if all were harvested	291.97
Cost per hamper if all were harvested	1.21

the acre cost would have been $291.97, or $1.21 per hamper. The farmers received an average of 74½ cents per hamper for those sold, or $133.88 per acre, which indicates what a discouraging market they had for their product. It is generally expected that cooperative associations can better the processes of distribution so that in a year of large production such as last year, part of this loss could be eliminated by putting a better and more uniform product on the market. With this end in view, many of the onion growers have formed such a cooperative association and just started to ship onions with established grades.

Growing the onion crop requires intensive farming, as shown by table 2. The four principal items of cost were:

1. **Sets:** 8.56 bushels, costing $43.02, or 15 per cent of the total cost.
2. **Fertilizers:** 1276 pounds, costing $37.79, or 14 per cent of the total cost.
3. **Manures:** 9.4 tons, costing $36.76, or 13 per cent of the total cost.
4. **Man labor:** 240.2 hours, costing $84.30, or 30 per cent of the total cost.

Cost of Milk Production, 1921

At the request and with the cooperation of the New Jersey State Federation of County Boards of Agriculture, a survey was made to determine the cost of producing milk in North Jersey (Sussex County), and South Jersey (Salem and Cumberland Counties) for the current year, 1921. Table 3 shows the relative costs in the two sections with the factors in detail which make up these costs.

This table shows some figures which are well worth the consideration of every dairyman. It is the opinion of many that higher producing cows mean that milk is being produced at a lower cost per quart. The cows on the 15 farms in South Jersey were producing an average of nearly 500 quarts, or over 1,000 pounds more per cow annually than those of Sussex County. Yet the cost of production per quart in South Jersey was 6.78 cents as compared to 6.75 cents in Sussex County. The higher production is obtained, naturally, by feeding more concentrates, more roughage, and using more labor. Among other items which are of importance when considering high-producing cows is their higher value, which gives a higher cost in interest and depreciation; also in securing the high production, it will be noted that the miscellaneous cost was $8.21 as compared to $5.98 or $2.23 more per cow in South Jersey. This means that these higher-priced cows were requiring more attention in the way of cow testing, tuberculin testing, and the care of the veterinarian. The cost in buildings and dairy equipment per cow are considerably higher in South Jersey.

Table 3

Cost of Milk Production in New Jersey, 1921

ITEM	Sussex County		South Jersey	
	Amount	Cost	Amount	Cost
Concentrates	2577 lbs.	$51.54	2597 lbs. 392 lbs.	$53.71
Roughage—				
Hay	3167 lbs.	45.51	2362 lbs.	
Stover	665 lbs.		1032 lbs.	43.83
Silage	2075 lbs.		6392 lbs.	
Pasture	4 mo.	8.00	6 mo.	16.78
Bedding			1.338 tons	11.33
Man labor	182.6 hrs.	57.34	202 hrs.	54.54
Horse labor	20.1 hrs.	4.00	16.34 hrs.	3.27
Dairy equipment		.75		3.30
Building cost		10.16		16.50
Taxes per cow		2.41		2.22
Interest per cow		8.28		8.52
Depreciation		11.04		11.36
Bull service		4.43		7.13
Miscellaneous		5.98		8.21
Management		20.94		25.06
Truck			6.6 hrs.	9.90
Total cost per cow		$230.38		$275.66
Value of manure		12.00		26.40
Value of calves sold		14.59		11.39
		$26.59		$37.79
Net cost per cow		$203.79		$237.87
Cost of milk per quart		6.75c.		6.78c.
Cost of materials used in producing milk—				
Hay per ton		$21.46		$18.32
Stover		12.00		6.64
Ensilage		7.27		5.87
Concentrates		40.00		37.00
Pasture per month		2.00		2.79
Man labor		0.314		0.27
Value per cow		138.00		142.00
Interest, 6 per cent				
Production per cow per year		3019 qts.		3510 qts.

Materials Required to Produce Milk

Concentrates. South Jersey dairymen required 2,989 pounds of concentrates per cow, or 412 pounds more than Sussex County.

Roughage. South Jersey dairymen were feeding 9,786 pounds of roughage, as against 5,307 pounds in North Jersey, the chief difference being in the silage, which was used at the rate of 6,392 pounds per cow in South Jersey as compared with 2,075 pounds in North Jersey. This larger amount of silage did not seem to produce any cheaper milk, although a higher production was obtained.

Pasture. South Jersey dairymen used pasture for 6 months of the year, while Sussex County farmers could pasture but 4 months. This pasture was on higher-priced ground. The additional pasture did not seem to reduce the cost per quart.

Bedding. In the use of bedding the South Jersey dairy practice differs considerably from that of North Jersey. In the southern counties, stalks, straw and meadow hay are used to the extent of 1.338 tons per year. This large amount, relatively speaking, is used chiefly with the idea of producing the maximum amount of manure which is used quite largely on cash crops such as potatoes or tomatoes. Sussex County does not have this opportunity, and hence this item is not so large in their costs.

With man labor 4 cents an hour cheaper in South Jersey, with the larger amount of silage being used and with 2 months longer for pasture, it might seem that milk should be produced cheaper per quart in South Jersey than in North Jersey, especially with over 1,000 pounds more production per year. But this increased production requires so much more feed in the way of concentrates and roughage, it takes 20 hours more of man labor, and with the additional overhead and interest per cow, depreciation, dairy equipment, building cost and extra care necessary with more valuable cows, it cost just as much per quart to secure this extra production. If the dairyman is receiving a price for his milk in excess of what it is costing him, he would make more money, but if his price is lower than the cost of production, the higher production would not be very profitable. The cost in South Jersey would have been still higher, except for the fact that the cost of materials used in producing milk such as hay, stover, ensilage and concentrates, was somewhat lower than North Jersey. Labor was cheaper on the South Jersey farms probably because of the fact that they are nearer to the industrial centers and the surplus labor of the cities would reach them sooner than in Sussex County section. Also, labor has a tendency of avoiding strictly dairy sections.

It is evident that cows have a certain capacity for the economical conversion of feed and care into milk, but the stimulation to greater production may easily cost too much for a reduction in cost per quart. In other words, it is necessary to study very carefully where this line is, between the natural producing power and the forced production of the individual cow.

Cost Accounts

For the year 1920, 40 cost accounts were started between January 1 and April 15 on selected farms in the southern part of the state. Thirty-five of the farmers completed their accounts, keeping complete records of all their activities and farm operations. These records have not been tabulated in sufficient detail yet to report on, but we will be able to obtain the actual cost of all items entering into the production of farm products such as man labor, horse labor, equipment, tractor and truck labor. When they are completely tabulated, interpretation can be made of the various methods in use which affect the organization of the farm and the cost of production.

For the coming year, the season of 1921, 44 cost accounts are being kept on this project, including 25 original cooperators, 3 in Sussex County, in cooperation with the county agent, F. Leon Brown, and 10 in Cumberland County, in cooperation with the county agent, M. Robert Trimnell.

The actual cost of horses when found on these cost accounts will be compared with the cost of operating the tractor and truck which has been determined by the survey method and is discussed below.

Cost of Tractor Operation

According to the latest available information, there are 800 tractors used on New Jersey farms.

Under war-time conditions of labor scarcity and high costs of both man and horse power on the farm, the use of power equipment such as the tractor and truck was rapidly developed. However, with the readjustments in farm-crop prices, costs of man and horse power, as well as the supply of labor available, it is highly essential that the present owner and the prospective purchaser should consider carefully the relative cost of work accomplished by the tractor and by the horse, in addition to whatever modification of his farm organization is possible.

With this idea in view, the New Jersey Agricultural Experiment Station, cooperating with the Monmounth County Board of Agriculture, made a survey to determine the cost of operating tractors in New Jersey, and their effect on the farm organization.

Records were obtained of 88 tractors distributed as follows:

Monmouth County	36
Burlington County	48
Cumberland County	4

Are Tractors a Paying Proposition?

The figures in table 4 are presented for the analysis and information of the individual farmer.

Table 4

Cost of Tractor Operation

ITEM	Field Work		Belt Work
	Amount per Hour	Cost per Hour	Cost per Hour
Lubrication—			
a. Cylinder oil (gal.)	0.123	$0.083	$0.085
b. Cup grease (lbs.)	.055	.009	.009
c. Transmission oil (gal.)	.021	.014	.012
Repairs and new parts		.199	.175
Insurance and taxes		.013	.014
Man labor	.105	.044	.044
Horse, auto use		.001	
Interest 6 per cent		.118	.118
Depreciation		.509	.48
Use of buildings		.016	.015
Total cost except for fuel and operator		$1.012	$0.952
Kerosene (gal.)	.90	.164	.153*
Gasoline (gal.)	.75	.219	.088†
Total fuel (gal.)	1.65	.383	.241
Operator's time		.40	.40
Total of all costs		$1.795	$1.593

*For 0.84 gal.
†For 0.30 gal.

The average cost per hour of field work performed by the tractor was $1.395, in addition to the cost of the operator which has been taken at the flat rate of 40 cents per hour.

Distribution of Costs

Five items of cost make up 94 per cent of the operating cost, exclusive of the operator.

1. *Depreciation* amounted to $0.509 per hour, or about 36½ per cent of the running cost.

The average number of seasons these tractors had been operated was only 1¾, and the average of the operators' estimates of the expected use to be obtained was 4¼ years more, or a total of 6 years. However, it is only fair to say that these tractors had not been in use long enough to determine the matter of length of life, and until they have been actually run until worn out, it is an open question as to just how long they will last. This is borne out by the following table, showing the number of seasons actually used thus far:

Number of Tractors	*Seasons Used*
41	1
30	2
14	3
3	4
88	Average 1¾

Six years of life would mean a depreciation of 16⅔ per cent per annum on a machine representing an average investment of $1,064, besides equipment averaging $327. This outlay would be somewhat less at the present time with the price reductions that have been made.

2. *Fuel cost* was $0.383 per hour of field work when full power was required, and $0.241 per hour of belt work. Field work used 1.65 gallons of fuel as against 1.14 gallons per hour of belt work. This fuel, as indicated in the table, represents the combination of kerosene and gasoline, some machines using either one or the other exclusively, while some used a combination.

3. *Repairs and new parts* cost $0.199 per hour, or 14 per cent of field cost per hour. This high cost per hour is on a group of tractors that have been in actual use but 1¾ seasons, and no doubt in the following years will be greater on the same set, unless the cost of repairs should decrease materially.

4. *Interest* amounts to 11.8 cents per hour, or 8.4 per cent of the total cost. This has been figured at 6 per cent of one-half of the original cost.

5. *Lubrication* has cost 10.6 cents per hour, or 7.6 per cent. In quantities of materials, it has taken 0.055 pound of grease per hour of field work and 0.144 gallon of cylinder and transmission oil.

Miscellaneous costs making up about 6 per cent of operating costs included such items as insurance, taxes, man labor and horse or auto use, and the use of buildings.

How Much is the Tractor Used?

The cost of operation is directly affected by the amount of work accomplished and the number of days or hours the tractor can be used.

Table 5 shows that the tractor was used for field work 317 hours and for belt work 49 hours during the year, or about 32 days and 5 days, respectively. Field work represented 86.2 per cent and belt work 13.8 per cent of total time used.

The significant facts shown by this table are the difference in the number of hours used and the cost per hour of use for Monmouth and Burlington Counties. It is explained by the fact that the tractors in Monmouth County were practically all on specialized potato farms, while those in Burlington County were on farms where orchards were a considerable part of their acreage, as indicated by table 6.

The actual running expenses of the tractor on the potato farms were $1.62 per hour of field work as compared to $1.23 where fruit was a dominant crop, exclusive of the operator's time. This fact allowed the tractor in Burlington County to be used 114.7 hours more per year, at a cost of 39 cents less per hour.

Table 5

Hours and Cost of Use of Tractor

COUNTY	Number	Average Number of Hours of Field Work	Average Cost of Field Work per Hour	Average Number of Hours of Belt Work	Per Cent of Field Work	Per Cent of Belt Work
Monmouth	36	230.2	$1.62	34.4	87.01	12.99
Burlington	48	344.9	1.23	63.4	84.47	15.53
Cumberland	4	544.2	.....	11.5	97.91	2.09
Totals	88	317.	$1.395	49.2	86.2	13.8

The number of hours a tractor was used ranged from 77 to 821 hours with the corresponding range of cost per hour of $3.88 and $1.31, respectively, for field work.

Interest and depreciation charges make the cost prohibitive when the tractor is not used at least a reasonable amount.

The time element in preparing ground, especially with a late spring and a cash crop like potatoes, is sometimes deemed one of the deciding factors when considering the advisability of having a tractor.

Cost of Plowing

The average rate of plowing was 6.22 acres per day, being somewhat higher in Monmouth than in Burlington County. It cost $2.44 per acre in Monmouth, and $2.06 in Burlington for plowing, exclusive of the operator's time.

Table 6

Acreage of Crops Grown Before and After Purchase of the Tractor

CROP	Monmouth County, 31 Farms			Burlington County, 43 Farms		
	Before	After	Increase or Decrease(−)	Before	After	Increase or Decrease(−)
	acres	acres	per cent	acres	acres	per cent
Potatoes	1365	1580	15.7	1012	818	—19.2
Orchards	283	282	....	1065	1332½	25.1
Wheat and rye	835½	751	10.0	675	803	19.0
Corn for grain	563	603	7.1	1007	999	—0.8
Corn for silage	30	30	....	134	134	....
Hay	651½	713	9.4	1315½	1388½	5.5
Miscellaneous crops	108	105	—2.8	248	297	20.0
Tomatoes	....	....	....	259	343	32.4
Peas and beans	....	....	....	86	98	14.0
Total crop acres	3836	4064	5.9	5801½	6213	7.1

Table 7

Amount and Cost of Work Done by a Tractor

COUNTY	Area Plowed in a 10-hour Day	Cost per Acre of Plowing	Area Harrowed and Disked in a 10-hour Day	Cost per Acre of Harrowing and Disking
	acres		acres	
Monmouth	6.63	$2.44	12.4	$1.30
Burlington	5.92	2.06	16.8	0.73
Totals or Average	6.22	$2.24	16.1	$0.87

Cost of Harrowing and Disking

The average number of acres harrowed and disked per day was 16.1, the rate in Burlington County being 16.8, or 4.4 acres more per day. This difference, no doubt, is due to the orchard work where not quite the entire ground can be worked. The relative costs per acre were $1.30 in Monmouth and $0.73 in Burlington, or an average of $0.87 per acre. These two operations are placed together because in some cases they were done in one operation, though not always.

Other Field Work Done

The above-mentioned operations, plowing, harrowing and disking, were by far the major part, or 85 per cent, of the field work done by tractors. The other 15 per cent consisted of miscellaneous operations such as hauling manure and hay, cutting corn, reaping, etc.

From table 8, we note five direct effects of the tractor on farm organization and practice.

1. The size of farm has been increased 7.4 crop acres in Monmouth and 9.5 crop acres in Burlington County.

2. The depth of plowing has increased 0.6 inch in Monmouth and 1.3 inches in Burlington.

3. Horses have been replaced to some extent, but much more markedly on the fruit farms in Burlington County. In Monmouth County, 1.5 horses were replaced per tractor, while in Burlington 2.9, or about 3 horses, were replaced per tractor.

4. Man labor saved in Monmouth County amounted to 4.5 months per tractor. and in Burlington County 5.8 months per tractor.

5. Some farm equipment was disposed of, amounting to $26 per tractor in Monmouth County and $28 in Burlington County.

Truck Costs

With the increased use of motor trucks on the farm, it has been a question to many farmers whether it is economical for them to invest heavily in this type of equipment, and if so, under what conditions would it be an economical investment, and when it would not be profitable. With the idea of determining the cost of operating trucks and their effect in the farm business, the Experiment Station, in cooperation with the Monmouth County Board of Agriculture, secured records on 37 farm trucks in Monmouth and Burlington Counties at the same time that the tractor records were obtained. These truck records have not been entirely tabulated at the present time in form to interpret. The whole question of use of power on the farm, now that labor is more plentiful and the prices of farm products have fallen to such an extent, is one that requires careful investigation. It is hoped to continue this investigation on the cost

Table 8

Effect of Tractor on Farm Organization and Practice

	Monmouth County			Burlington County		
	Before	After	Number of Farms	Before	After	Number of Farms
Crop acres per farm	123.7	131.1	31	135	144½	43
Depth of plowing (inches)	7.96	8.56	31	6	7.3	43
Number of horses	280	227	36	374	236	48
Months of man labor saved		163.3	36		280½	48
Value of farm tools disposed of		$955			$1338	

of power farming and its effects on the farm organization. The survey records with the cost accounts will give the data upon which we can study the relative costs of tractors, trucks and horse power, with the resulting effect on the cost of production and the farm business.

NEEDS OF THE DEPARTMENT

The needs of the department have been indicated in a previous report and include chiefly equipment and personnel for crop research work, as well as a storage building suitable for the purpose of storing crops materials, seeds, fertilizers, and necessary equipment for the plot work. During the greater part of the past year the department has been without the assistance of anyone whose duties included regular experiment station work. The absence of the chief of the department has necessitated a curtailment of some of the projects under way, and full development of the research work awaits the return of the normal personnel of the department. However, all of the more important projects have been carried through, and with the addition of available space for plot work at the station, the department is better equipped than ever before to render service to its constituents.

Farm Management Needs

In order to give the most prompt and efficient service for the interpretation and collection of data bearing on the most economical methods of production, the personnel engaged in farm management work should be increased. It would facilitate matters greatly to have a field man who could take care of most of the cost accounting and survey field work, with an additional statistician in the office. As it is at present, at least one-half to two-thirds of the time is required in field work, following up cost accounts, and continuing the survey work. This naturally retards the most efficient service that could be rendered in completing as promptly as possible the tabulation and interpretation of data obtained.

Statement of Expenses for the Department of Agronomy and Agricultural Economics, July 1, 1920-July 1, 1921

Farm Crops	
Traveling	$268.39
Labor	11.08
Photographs	8.95
	$288.42
Farm Management	
Salaries	$1020.00
Traveling	1566.15
Supplies	173.50
	$2759.65
Miscellaneous	
Salaries	$1240.00
Supplies	322.06
	$1562.06
Farm Crops	$288.42
Farm Management	2759.65
Miscellaneous	1562.06
Total	$4610.13

REPORT OF THE DEPARTMENT OF BIOLOGY

Department of Biology

Thurlow C. Nelson, Ph.D., Biologist.

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REPORT OF THE DEPARTMENT OF BIOLOGY

THURLOW C. NELSON

INTRODUCTION

The scope of the work of this department has been extended during the past year through the appointment of the writer on July 1, 1920, as biologist of the State Board of Shellfisheries. This new appointment in no way altered his status as biologist of the Experiment Station but was made possible through grant of one year's leave of absence from the Department of Zoology of Rutgers College, thus permitting full time for oyster investigations.

The activities of the department may be grouped according to the topics discussed throughout the following pages.

The winter of 1919-20 was unusually severe, even the larger bodies of water of the state being solidly frozen over for about 6 weeks. When the break-up came with the violent northeast storm and record high tide of February 5 and 6, 1920, the heavy ice of Little Egg Harbor was carried in great sheets across the marshes toward the Tuckerton Radio Station and completely destroyed the original laboratory for oyster research built in 1904 at Stopwater Creek by Dr. Julius Nelson. This building, which had not been in use since 1908, was erected at a cost of less than $100. It contained nothing of value when destroyed.

During the same storm a new inlet was cut through the beach into Little Egg Harbor a few miles below Beach Haven. The effect of this new communication with the sea, much closer to the oyster beds, has been to cause a marked increase in the density of the water with the results explained in section 4 of this report.

RESEARCH

1. Studies of the Rate and Extent of Growth of Adult Oysters (Concluded)

In the report of this department for 1920 (p. 320-324) are given the results of studies of the rate and extent of growth of oysters from April to August, 1919. As stated there, the tagged experimental oysters were wintered at Elder Creek, Great Bay, with a mortality of but 1.5 per cent.

The oysters were removed March 30, 1920, cleaned, weighed and measured as before, the results of 1 year's growth being given in table 1. Because of corrosion by the mud and salt water, as well as through the crumbling of the shells of the oysters, many tags were lost or became illegible, hence but 230 individuals out of the original 1,000 were available for these 1-year measurements. They represent, however, a fair sample of the group as a whole.

As seen in table 1, the Grassy Channel seed in 1 year increased two-thirds of the original weight, over one-fifth the original length and over one-fourth the original width. The Huey's Creek naturals increased about one-half in weight, one-fourth in length and one-fifth in width. The ratio of increase of length to width was as follows: Huey's Creek naturals, 1 to 0.807; Grassy Channel stock, 1 to 1.187. This difference, as explained in our last report, was due to the fact that the naturals having grown singly from the start were rounded and normal in shape, hence grew comparatively more in length than in width, whereas the Grassy Channel seed, having been crowded during the first two years of growth, were elongated and tended when separated to correct this condition by a relatively greater increase in width than in length.

Table 1

Growth of Oysters

OYSTERS	Number Counted	Period	ORIGINAL			INCREASE		
			Weight	Length	Width	Weight	Length	Width
			gm.	cm.	cm.	gm.	cm.	cm.
Huey's Creek Naturals...	13	1 year	1157	110.6	70.0	609	27.0	13.8
Average	1	1 year	89	8.5	5.4	46.8	2.1	1.1
Grassy Channel seed....	217	1 year	18514	2024.9	1193.1	12238	440.4	308.8
Average	1	1 year	85.3	9.3	5.5	56.3	2.0	1.4
PER CENT INCREASE						per cent	per cent	per cent
Huey's Creek Naturals						52.6	24.4	19.7
Grassy Channel seed						66.1	21.7	25.8

The growth of the oyster in northern waters occurs in two periods. The first, or spring, growth begins in New Jersey about the middle of March and continues rapidly until the spawning period and more slowly thereafter. During this spring and summer growth period a large amount of very thin new shell is secreted about the margins of the old one, there being but little increase in the thickness of the

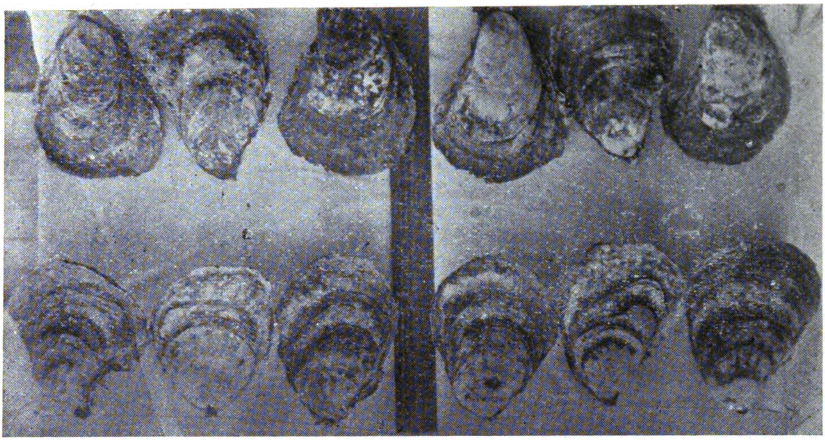

FIG. 1. PRIME OYSTERS, 4 YEARS OLD, FROM GROWTH EXPERIMENTS BEGUN IN THE SPRING OF 1919. FROM LEFT TO RIGHT THEY ARE: UPPER ROW, NOS. 597, 817, 602, 594, 845, 843; LOWER ROW: NOS. 146, 896, 489, 851, 709, 582. NO. 146 IS A HUEY'S CREEK NATURAL, THE OTHER ELEVEN ARE FROM GRASSY CHANNEL SEED WHICH SET IN THE SUMMER OF 1916. THE OYSTERS WERE REMOVED AND PHOTOGRAPHED ON NOVEMBER 9, 1920. THESE OYSTERS, WHICH AVERAGED A LITTLE OVER 5 INCHES IN LENGTH, SHOW THE POSSIBILITIES OF RAISING EXCELLENT AND WELL-SHAPED OYSTERS ON RAISED PLATFORMS IN A RAPID CURRENT.

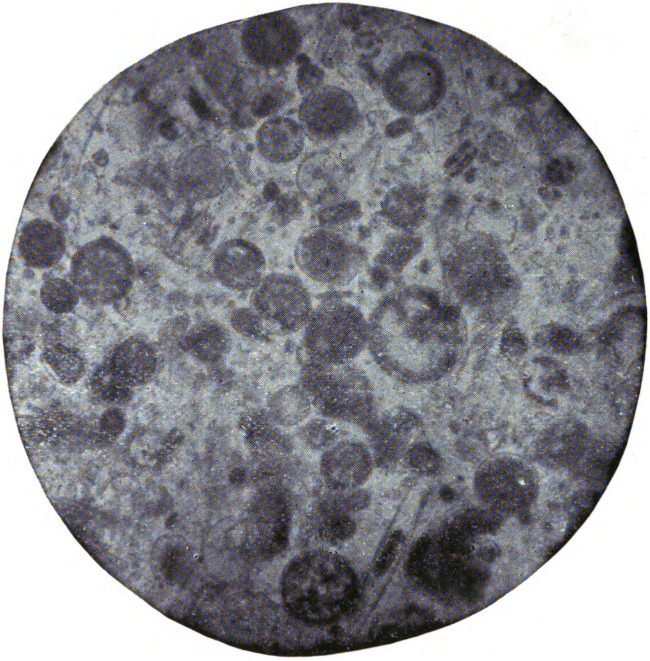

FIG. 2. STOMACH CONTENTS OF OYSTERS; FIELD TAKEN AT RANDOM TO SHOW THE GREAT NUMBERS OF DIATOMS, MOSTLY *Coscinodiscus*, FOUND IN THE STOMACHS OF OYSTERS AT EDGE COVE ON DECEMBER 15, 1920, WITH THE WATER TEMPERATURE AT 46° F.

animal. Following the close of the spawning period the oyster again begins rapid growth, the increase, however, being mainly in the thickening of the new shell and enlargement of the body and of the shell cavity.

This difference between the spring and the autumn growth periods is well illustrated in table 2. The increase in weight for the year, 66.1 per cent, was about equally divided between the two periods; while of the 21.7 per cent increase in length and the 25.8 per cent in width, 18.5 per cent and 21.5 per cent, respectively, occurred during the spring period. As every oyster grower knows, the spring is the time of the greatest extension of the shell which in the fall becomes much thickened as the valves are pushed farther apart and the size of the shell cavity and of the meat is increased. In other words, spring and early summer are a time of extensive shell growth, while the autumn is a time of shell thickening and of body growth and fattening.

After weighing and measuring the oysters a further experiment was conducted to study the growth of the bivalves on a platform and on the bottom, to check the similar experiment carried out during 1919. One hundred oysters were put on a platform so placed as to be awash at low tide, and the same number were placed in a wire tray and set on the bottom, 4 feet below. The results of this experiment after 7 months' growth are given in table 3. As shown in this table, the increase in weight was practically identical in both lots, while there was about 6 per cent greater increase in length and 5 per cent greater increase in width in the platform series.

From this experiment and the similar one described in our last report (page 323) it may be concluded that oysters on the bottom if not imbedded therein will grow as well as do those kept on a platform under optimum conditions for growth.

2. Studies of the Seasonal Variations in the Food of the Oyster (Continued)

The data accumulated since March, 1919, relative to the food of the oyster, have become so extensive that it is planned to publish them in a separate bulletin as one of the series of which Bulletin 351 is the first. In brief, the results of this last years's work confirm those of the preceding year as given in our report for 1920 (p. 324-333).

Prof. G. W. Martin, of the botany department of Rutgers College, has undertaken an independent investigation to determine the part played in the oyster's food by plankton organisms and those living on the oyster's shell, together with the relative percentages of diatoms and other algæ, animal plankton, eel grass, and detritus occurring in the oyster's stomach.

Table 2

Comparison of Spring and Autumn Growth—Grassy Channel Seed

PERIOD	Weight	Length	Width
Average increase in 1 year	56.3 gm.	2.0 cm.	1.4 cm.
Per cent increase in 1 year	66.1%	21.7%	25.8%
Average increase from April 12 to August 12, spring-summer growth*	27.6 gm.	1.9 cm.	1.2 cm.
Per cent increase, spring-summer growth*	31.6%	18.5%	21.5%
Average increase from August 12 to March 30—autumn growth	28.7 gm.	0.1 cm.	0.2 cm.
Per cent increase, autumn growth	34.5%	3.2%	4.3%

*From Annual Report for 1920 (5).

Table 3

Comparison of Rate of Growth on Platform and on Bottom

	Number	Period	March 30, 1920			Increase in 7 Months		
			Weight	Length	Width	Weight	Length	Width
Platform Series			gm.	cm.	cm.	gm.	cm.	cm.
	65	March 30 to Nov. 4	8911	703.4	448.0	2978	141.5	85.8
	Average	March 30 to Nov. 4	137	10.8	6.9	45.8	2.2	1.3
						per cent	per cent	per cent
	Per cent increase...........		......	......	......	33.4	20.1	19.1
Bottom Series	60	March 30 to Nov. 4	8596	688.1	412.5	2838	98.1	59.0
	Average	March 30 to Nov. 4	143.3	11.5	6.9	47.3	1.6	1.0
						per cent	per cent	per cent
	Per cent increase...........		......	......	......	33	14.2	14.3

3. Influence of Temperature on the Rate and Extent of Feeding of Oysters

The monthly examinations of the stomach contents of oysters begun early in 1919 were continued throughout the past year. The results of these stomach analyses confirm those given in our last report. On account of the unusually warm and cloudless autumn of 1920, there was a great development of food organisms in the water. During this same time the oysters shipped from the Delaware Bay and from the New Jersey coast were of a fatness and condition not excelled in the past 25 years. The many calm days in October and November resulted in very clear water, it being possible at times in Delaware Bay to see an oyster shell on the bottom at a depth of 14 feet. This deep penetration of the sunlight greatly favored the development of food organisms, while the clear water was in itself a great aid to the feeding of the oysters.

It was shown, furthermore, that as in the case of spawning (2, p. 10) the oyster shows a "critical temperature" also in its feeding habits. For example, in the autumn of 1919 the water was very rich in food organisms; on November 28, with water temperature of 45° F., density 1020, a plankton sample showed over 17 million filamentous diatoms *(Melosira)* per 100 quarts. Oysters examined at this time had the stomachs filled with this organism. A severe cold spell about December 15 froze the surface of the water for a few days. Examination of oysters on December 22 with water temperature at 33° F., density 1021, showed mere traces of food present in the stomachs. No feeding occurred thereafter until after the middle of March.

In the autumn of 1920 oysters were feeding actively until after the middle of December. An examination on December 15, with the water temperature at 46° F., density 1022, showed the oysters' stomachs filled with rich food material (pl. 1, fig. 2). No freezing occurred during the very warm open winter which followed, and the water was at all times very rich in food organisms. On February 10, 1921, with the water temperature at 41° F., density 10225, the water was like a thin "soup" of diatoms and other algæ, yet the stomachs of oysters examined at this time were empty save for the mere trace of diatoms and detritus always to be found in the oyster at low temperatures. On March 5 (water temperature 45° F., density 10215) the stomachs of the oysters contained much detritus and many diatoms, showing that the oysters again were feeding actively. Between 42° and 45° F. lies, therefore, a "critical temperature," above which there is active feeding, and below which almost no food is taken.

These observations are in accord with those of Round (6) that oysters will actively eliminate bacteria at all temperatures above 9° C. (48° F.), while at 5° C. (41° F.), no reduction in the number of bacteria occurs until after 5 days. He believes that between these temperatures oysters close their shells for longer or shorter periods, but that there is no temperature above the freezing point at which oysters close their shells for an indefinite time. We have found minute slime strings containing living diatoms passing from the palps into the stomachs of oysters with the water at 32° F. even after the oyster beds had been covered by ice for nearly two months. From the freezing point up to 41° F., or slightly above, the oyster is just active enough to cause a feeble current of water to pass to its gills and from this water it obtains oxygen and a very minute amount of food. Between 41° and 45° F., by means of heightened ciliary action, the ingestion and digestion of food are very greatly increased.

4. Further Investigations of the Distribution and Behavior of Oyster Larvae

There was no "set" of any importance on the oyster beds of the New Jersey coast during the summer of 1920. A fair set occurred on the natural grounds and on some of the planted beds of Delaware Bay. There follows a summary of conditions by districts.

Little Egg Harbor

Because of the presence of the new inlet, as explained in the introduction, the density of the water at Edge Cove at high tide averaged 10200, as against 10177, for the previous season. On November 8, 1920, the water at Edge Cove at high tide was 10240, temperature 53° F., or only about two points under oceanic saltness, 10260. The most important effects felt thus far have been the extension of the area of activity of the drumfish and the invasion of the oyster beds by the black mussel *(Mytilus edulis)*, a form which normally is confined to a narrow region just inside the inlet.

The spring of 1920 being unusually cold and backward, oyster larvæ did not appear at Edge Cove until June 9, when 3 larvæ, 1 day old, were found per 100 quarts of water, 1019 at 70° F. The first spawning of importance occurred June 11, as shown by 800 larvæ per 100 quarts on the twelfth, water 1019 at 73° F. A second heavy spawning occurred on the twenty-ninth when 803 larvæ were taken. The principal spawning of the summer came on July 2, 2900 larvæ per 100 quarts being found on the third, water 1018 at 77° F. These larvæ grew rapidly at the high temperatures of the water which prevailed during this time, 77° to 80° F., and set from July 13 to 16. Experimental shells placed on the eleventh and removed on the sixteenth showed an average of 45 spat per shell. The set was general in the first two reaches of Huey's Creek above and below the floating laboratory. A light set occurred near the mouths of Willet's Thorofare and of West Creek over very restricted areas. There was no general set in Little Egg Harbor.

Great Bay

A heavy set of black mussels *(Mytilus edulis)* caught on the oyster beds over most of Great Bay during the late spring and early summer of 1920. These grew rapidly and made necessary the removal of the oysters from many of the beds during the summer. A second heavy set of mussels struck over the same area early in May, 1921, but up to the present writing have grown very little, being less than 1/4 inch in length.

No mass spawning occurred in this region during the summer of 1920, very few oyster larvæ appeared at any time, and these did not mature. Clam and snail larvæ also were very scarce. There was no set in Great Bay nor on the natural beds of the Mullica River.

Large quantities of oil and grease from the garbage plant at Seven Islands were carried over the beds of Great Bay and up the Mullica River with each flood tide. These substances were most noticeable during the hot weather which occurred during the spawning period, the heat of the sun melting the fats, which then seeped over the sides of the garbage scows into the water. Often the entire bay was covered by a continuous film of oil so thick that oyster and clam tongers were hardly able to hold the stales of their tongs, so slippery were they from the coating of grease. To what extent this film of oily substances on the water may have prevented the maturing of oyster larvæ in Great Bay last summer is problematical. It undoubtedly did have some injurious effects, as the writer has shown elsewhere (3, 4).

Barnegat Bay

A fair set occurred here over a few of the beds, there was no general set of importance. Plans have been laid to station the floating laboratory at Bayville during the summer of 1921 and to conduct a survey of the waters of Barnegat Bay to determine the abundance and distribution of the oyster larvæ there.

Delaware Bay

Investigations were begun by the writer in this region for the first time on July 13, 1920, and included a study of the number and distribution of the oyster larvæ in the water, the extent of the season's set upon the natural beds, the injury done by the oyster drill *(Urosalpinx cinerea)* and the effects of pollution upon the natural beds of upper Delaware Bay. A detailed account of the investigations in this region is found in the report of the Board of Shellfisheries for 1921.

The results may be summarized as follows: Oyster larvæ were present in abundance during July and August. Setting commenced unusually late, the first spat found on the natural grounds set July 27 on the lower Egg Island beds. From this time until August 12, when the last examination of the summer was made, setting was continuous. A brief survey of the natural beds in August, 1920, showed an average of 2 spat per shell on the main Cohansey bed, 4 per shell on the lower Egg Island beds, 8 per shell on New bed, and 9 per shell on Bennies bed.

Examination of the seed on May 2, 1921, at the opening of the natural beds, showed that with the exception of that on the Egg Island beds just above the "Southwest Line," practically all the set of the previous summer had lived. The lower Egg Island beds showed the following: Alive, 74 per cent; drilled, 8 per cent; dead from other causes, 18 per cent. The water here on this date, tide one-third ebb, registered a density of 1015, temperature 59° F. The natural grounds as a whole appeared to be in excellent condition and well able to furnish the amount of seed required for the season's planting.

One of the most important results of the season's work in Delaware Bay was the demonstration of the reactions of the oyster larvæ to the ebb and flow of the tide as described elsewhere (2, p. 35). By rising on the flood tide and sinking during the ebb close to or on the bottom, the larvæ are carried by successive flood tides back toward the headwaters and are thus prevented from being lost seaward and are carried back to the beds whence they originally came.

5. The Spawning of Oysters

The act of spawning of oysters was observed on June 26, 1920, and has been described in detail in another paper (2, p. 11-16). Oysters in a group were shown to spawn simultaneously, the females shooting out the eggs in a fan-shaped cloud, by regular contractions of the adductor muscle forcing out the water from between the shells, and with it the eggs. In the males the valves remained stationary, gaping about 1/8 inch, while a thick stream of milt issued from between them and melted out into the water (pl. 2, fig. 1). Fertilization of practically all of the eggs followed within a few minutes, so that even where carried by a swift current there would be little chance for fertilization of the eggs by spermatozoa from a nearby bed downstream. Spermatozoa, however, might be brought from a bed upstream and fertilize eggs just spawned, though they would be greatly outnumbered by the spermatozoa thrown out by neighboring males.

By good fortune two of the oysters attached to the recording apparatus used for the study of feeding, as described in our report for last year (p. 334-335) spawned while these experiments were going on. With the contractions of the adductor muscle coming about once in every 30 seconds the strokes of the pen were very close together and became somewhat blurred, but the curve illustrates the evenness in extent and duration of the contractions (pl. 2, fig. 4). It is almost as though an automatic mechanism were put in action at the onset of spawning in the female.

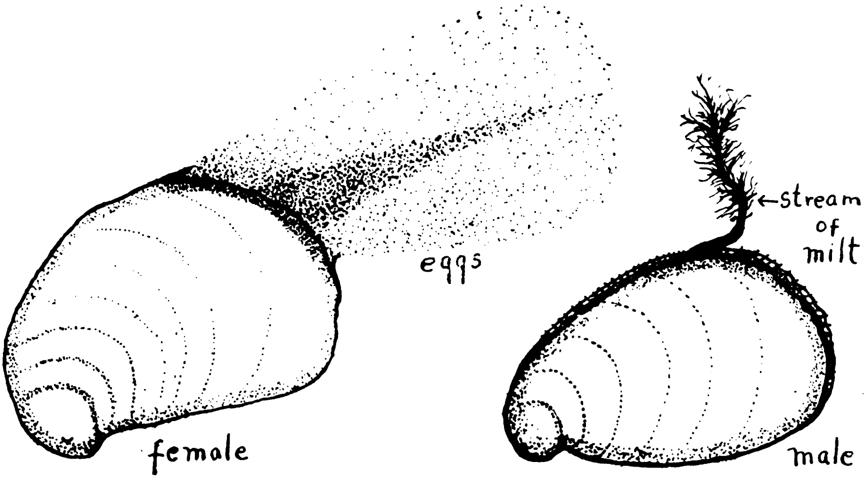

FIG. 1. THE SPAWNING OF OYSTERS, SOMEWHAT DIAGRAMATIC, TO SHOW CLOUD OF EGGS FORCED OUT BY THE RAPID CONTRACTION OF THE ADDUCTOR MUSCLE IN THE FEMALE AND THE STEADY STREAM OF MILT, OR SPERMATOZOA, ISSUING FROM THE MALE.

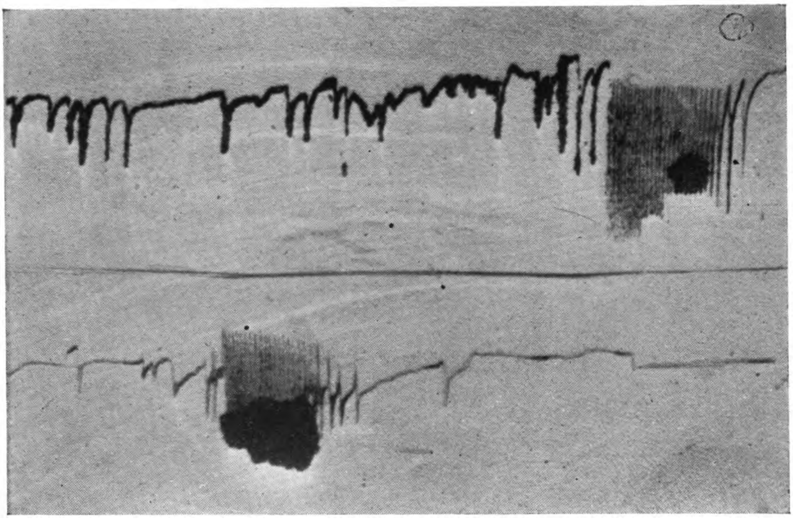

FIG. 2. THE SPAWNING OF OYSTERS; THE CHIMOGRAPH TRACING MADE BY TWO FEMALE OYSTERS WHICH SPAWNED WHILE ATTACHED TO THE APPARATUS USED TO RECORD FEEDING REACTIONS. SPAWNING PERIOD REPRESENTED BY THE GROUPS OF VERTICAL LINES CLOSE TOGETHER CAUSED BY THE QUICK CONTRACTION OF THE ADDUCTOR MUSCLE IN FORCING OUT THE EGGS. (SEE ANNUAL REPORT FOR 1920 (5) FOR DESCRIPTION OF APPARATUS.) THE PORTIONS OF THE TRACING PRECEDING AND FOLLOWING THE SPAWNING PERIOD SHOW THE USUAL SNAPPING OF THE SHELL FOR THE REMOVAL OF ACCUMULATED WASTE. UPPER CURVE: OYSTER 1501, SPAWNING PERIOD AUG. 6, 1920, 4:18 TO 4:29 P. M., TIDE $^5/_6$ FLOOD. LOWER CURVE: OYSTER 1507. JULY 26, 10:37 P. M., TIDE HIGH.

The bearing of this observation of the spawning of oysters on certain practical methods of planting oysters should be pointed out here. Oyster growers often bring in oysters from distant localities for the purpose of "strengthening" the local stock. Continual inbreeding is held by them to result in weakened oysters. We know this to be true of other animals, and there is abundant evidence that interbreeding with "foreign" stock often does strengthen the native oyster seed. That is, seed from a region where the spawn comes from oysters transplanted there from other localities, as well as from the naturals, is more resistant to adverse conditions when transplanted; is better able to adapt itself to a new environment, and to thrive in new surroundings. Crossing with "foreign" strains is not necessary for the vigor of native oysters when these are not confronted by changed conditions, as is clearly evident from the immense natural oyster reefs of former days, before oysters ever were transplanted. On these reefs the most intensive inbreeding had been in progress for thousands of years prior to the coming of man.

Since oysters of a group spawn together, and since the spermatozoa when in the presence of the egg secretions lose the power to fertilize eggs within one hour or less (1, p. 296), it is important that oysters which it is desired to "cross" be placed as close together as possible, not planted on separate beds. It would be well to plant them together, well mixed, upon the same bed, or the "foreign" oysters could be spread scatteringly over the native stock.

Heredity and selective breeding form a field rich with possibilities in oyster culture, a field as yet practically untouched. Selective breeding, which has given us the 40-quart-per-day cow and the 1-egg-a-day hen, could give us also a superfine oyster. The difficulty lies in control, and not until all the oyster planters of a large region agree upon, and carry out, a definite program of stock selection can this "better oyster" of the future be realized.

6. Destruction of Seed Oysters by Drills

The planted beds of Delaware Bay, free as they are from the inroads of starfish and drumfish, are yet subject to the inroads of another enemy the injurious effects of which, while far less noticeable than those of the starfish or the drumfish, are nevertheless very serious because continuous, and often overlooked. The small oyster drill *(Urosalpinx cinerea)* is a curse of the first magnitude to the planted beds of Delaware Bay. Examination on October 7, 1920, of spat which set in July and August, 2 months previous, in sections A and B, showed from one bed 33 per cent drilled, from another, 41 per cent, and from a third, 50 per cent dead from this cause alone. Such an insidious enemy as this, working continuously, cannot fail to make serious inroads in the young seed oysters, both those which set upon the beds and those transplanted thither from the natural grounds. Experiments now are in progress to construct a trap which will capture the drills.

7. Pollution Studies

In cooperation with the State Department of Health a very brief survey was made on October 20-21, 1920, to determine, if possible, evidence of pollution by sewage and industrial wastes in the waters covering the natural beds of upper Delaware Bay. Two cross-sectional studies were made at dead low water; the first was run from Ship John Light to the mouth of the Cohansey River; the second from Arnold's Point Shoals to the mouth of Stow Creek. This brief survey failed to show evidences of serious pollution on the upper natural beds of Delaware Bay. (For details see the Report of the Board of Shellfisheries for 1921.)

ADMINISTRATIVE

As stated in the introduction, the writer was appointed biologist of the New Jersey State Board of Shellfisheries, July 1, 1920, under grant of one year's leave of absence from the department of zoology of Rutgers College. He will resume his duties in the college during the first semester of 1921, while retaining the position with the Board of Shellfisheries.

During September, 1920, the biologist attended, at his own expense, the National Convention of the American Public Health Association at San Francisco, California, and presented a paper to the Laboratory Section entitled, "Some Aspects of Pollution as Affecting Oyster Propagation." Advantage was taken of the opportunity while there of investigating conditions for oyster culture on the Pacific Coast, and prominent oyster growers, members of the California Fish and Game Commission, scientists and others interested in oyster culture, were interviewed.

The biologist also attended the annual meetings of the American Association for the Advancement of Science at Chicago in December, 1920. Two papers, with stereopticon illustrations, were presented: One before the American Society of Zoologists, entitled, "Observations of the Feeding Habits of Oysters"; the second, presented to the Ecological Society of America, was entitled, "Studies of the Distribution and Behavior of Oyster Larvæ."

In May, 1921, the writer was called to Providence, R. I., to give testimony as to the effect of oil upon oysters in the case of Rooks vs. The Mexican Petroleum Company. Although evidence of an unquestionable character was presented to show that oil was responsible for the death of the oysters on the beds, verdict was rendered for the defendant.

The biologist has been appointed chairman of a committee of the Ecological Society of America on Pollution of Inland and Coastal Waters. On June 16, at the invitation of Secretary Hoover of the

Department of Commerce, he attended a conference called to discuss problems of pollution and conservation as applied to fisheries. He was appointed by the Secretary of Commerce as member of a permanent committee on pollution, of which Kenneth Fowler of the American Fisheries Association is chairman.

On June 17, the writer, at the invitation of the U. S. Bureau of Fisheries, attended an informal discussion of problems concerned with experimental oyster culture, held at the office of the Deputy Commissioner in Washington. This was the third annual meeting of its kind which has thus far been held, and was designed to bring about closer cooperation between the Bureau of Fisheries and investigators of the several oyster-producing states who are engaged in research on oyster problems. The bureau, by thus coordinating research conducted in various states and serving as a clearing house for data collected, is rendering a valuable service to our department.

PUBLICATIONS

Papers published by the writer during the past year include Bulletin 351 and Technical Paper No. 38, of the New Jersey Agricultural Experiment Station, and a paper on "The Conservation of New Jersey's Oyster Industry" in the Report of the New Jersey Board of Shellfisheries for 1920 (p. 8-15).

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REPORT OF THE DEPARTMENT OF SOIL CHEMISTRY AND BACTERIOLOGY

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Report of the Department of Soil Chemistry and Bacteriology

JACOB G. LIPMAN

AUGUSTINE W. BLAIR

THE INFLUENCE OF THE MECHANICAL COMPOSITION OF THE SOIL ON THE AVAILABILITY OF NITRATE OF SODA AND DRIED BLOOD—1920

This constitutes the final report on this project, and rounds out a 10-year period during which the two forms of nitrogen have been compared in soils varying in mechanical composition from a loam to a pure coarse sand.

The detailed plan has been given in earlier reports and need not be repeated here.

Figure 1 indicates the arrangement of the cylinders with reference to the various dilutions and the amount of nitrogenous fertilizers used.

All cylinders have received annually 20 gm. of acid phosphate, 5 gm. of muriate of potash, 5 gm. of sulfate of potash, 38 gm. of calcium limestone, and 2 gm. of magnesium carbonate.

Two crops are grown each year, but the fertilizers are all applied for the first crop, the second crop being seeded as a residual crop to utilize any nitrogen not used by the first crop.

An experiment conducted in this way gives an opportunity to study the residual effect, and the cumulative effect, of organic sources of nitrogen, which a short-time experiment does not afford.

Barley, 1920

The results for the barley crop of 1920 are shown in table 1.

With only two exceptions, series *H* and *J*, the average yield of dry matter is greater with nitrate of soda than with dried blood.

The averages for all series are as follows:

Check	36.7 gm.
Nitrate of soda	118.6 gm.
Dried blood	104.4 gm.

These figures are in accord with results obtained in previous years.

With only one exception the average yield of nitrogen was greater with nitrate of soda than with dried blood.

Series	Arrangement of Cylinders	Soil	Fertilizer Treatment
A....	① ② ③ ④ ⑤ ⑥	Shale Soil	1,2 –nothing. **3,4** –10 gm. nitrate soda. **5,6** – 12 gm. dried blood.
B....	① ② ③ ④ ⑤ ⑥	10% sand	"
C....	① ② ③ ④ ⑤ ⑥	20% "	"
D....	① ② ③ ④ ⑤ ⑥	30% "	"
E....	① ② ③ ④ ⑤ ⑥	40% "	"
F....	① ② ③ ④ ⑤ ⑥	50% "	"
G....	① ② ③ ④ ⑤ ⑥	70% "	"
H....	① ② ③ ④ ⑥ ⑥	80% "	"
I....	① ② ③ ④ ⑤ ⑥	90% "	"
J....	① ② ③ ④ ⑤ ⑥	100% "	"

FIG. 1. PLAN OF EXPERIMENT.

The highest yields were obtained on series *A* and *B*, these being the straight loam soil and the loam with 10 per cent of sand. It is of interest to note that the yields do not diminish rapidly until the dilution reaches 70 per cent of sand, series *G*. The lowest yield is found with the pure sand, series *J*. In this series the blood shows greater staying or lasting qualities than the nitrate of soda.

The nitrate shows percentage recoveries varying from 2.47 in series *J* to 67.08 in series *A*.

The recoveries with dried blood vary from 23.7 per cent in series *J* to 47.08 in series *E*.

The average recovery for all series stands: nitrate of soda 47.66 per cent, dried blood 36.95.

If the averages for the first three series are taken, they are as follows:

Nitrate of soda	61.65 per cent.
Dried blood	39.53 per cent.

These figures are very close to the averages obtained for the original cylinders which have been under continuous observation since 1898 (2).

Buckwheat, 1920

Following the barley, buckwheat was seeded without further addition of fertilizers.

The results for this crop and the combined results for the two crops are recorded in table 2.

Considering, first, the buckwheat, the average yields of dry matter are invariably greater with dried blood than with nitrate of soda. The average yields on the check cylinders are in most cases slightly less than the yields with either the nitrate of soda or the dried blood.

The larger yields from the dried blood indicate a greater residual effect from this than from the nitrate. This residual effect is more pronounced with this crop than with any preceding crop. It is reflected in the percentage of nitrogen recovered, there being some recovery for all the series, with an average of 10 per cent for all, in comparison with 3.96 per cent for the nitrate of soda. (For two of the series, *D* and *J*, the nitrate shows a loss instead of a gain.)

The average percentage of nitrogen in the dry matter is practically the same for the nitrate and dried-blood cylinders as for the check cylinders. The averages for the series *I* and *J* are distinctly higher, however, than the averages for the remaining series. This appears to be characteristic of plants grown in a straight sand medium or under otherwise abnormal conditions.

The Combined Crops

The combined yields of dry matter for the two crops are shown in the first column of the summary, table 2. In this case the yields with nitrate of soda exceed the yields with dried blood in all series up to and including series *G*. For series *H* and *I* the yield with dried blood exceeds by a small margin the yield with nitrate of soda. For series *J* the yield with blood is nearly four times as great as with nitrate. This demonstrates again the effectiveness of organic nitrogenous substances in soils which are largely made up of quartz sand.

The average combined results for the 10 series are as follows:

Treatment	Dry Matter	Total Nitrogen	Nitrogen Recovered
	gm.	gm.	per cent
Check	62.3	0.69	....
Nitrate of soda	149.8	1.49	51.56
Dried blood	143.4	1.42	47.01

The highest recovery with nitrate is 72.53 per cent on series *E* and the highest with dried blood 66.36 per cent on series *C*. A recovery of only 1 per cent with nitrate on series *J* cuts down very materially the average for this material.

It is significant that with 80 per cent sand as in series *H* the recovery of nitrogen should be 45 per cent or over with both nitrate of soda and dried blood. It is quite evident that with two crops in a season it is possible to recover a considerably higher proportion of the applied nitrogen than with only one crop. The yields of dry matter and percentage of nitrogen recovered for the combined crops are indicated by curves shown in figure 2.

The 10-Year Summary

The average yields of dry matter and percentage of nitrogen recovered for the 10-year period are summarized in table 3. The results for 1911 are omitted from the average since corn was grown that year, whereas during the remainder of the period a main crop of barley and a residual crop of buckwheat were grown each season. From the table it will be noted that the yields with nitrate of soda increase gradually from 1912 to 1918, when the yield was 167.3 gm. per cylinder. The following year it was only 119.5 gm. per cylinder. A corresponding drop in yield is also noted in the check and also the dried-blood cylinders for 1919. Both crops were below the normal that year.

It will be noted that the nitrate gives a larger average yield and also a higher percentage recovery than the dried blood. In this connection it must be remembered that these figures are the averages of all the series, from loam soil to 100 per cent sand.

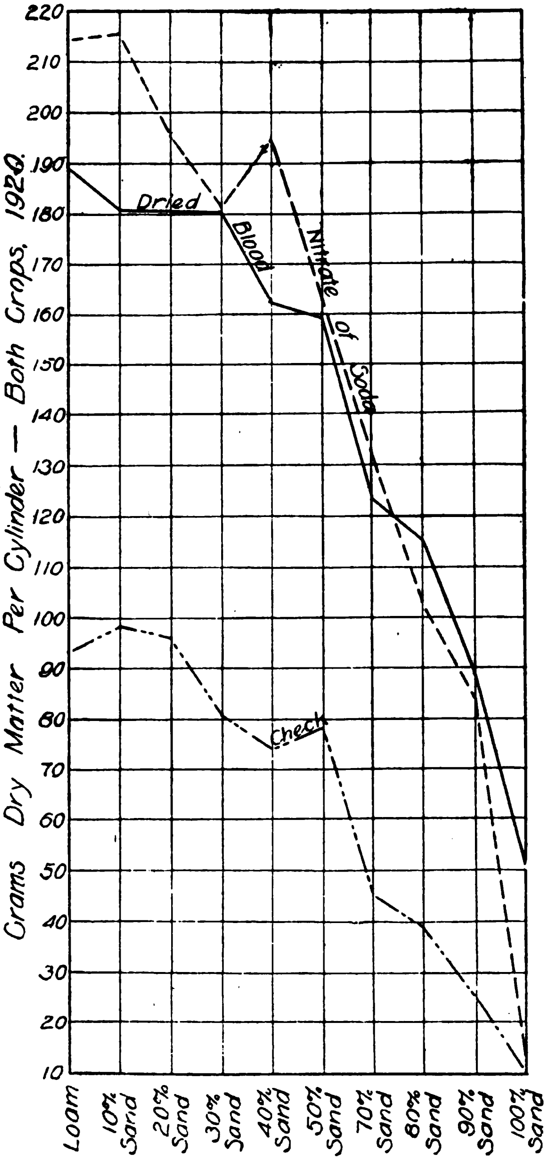

FIG. 2. WEIGHT OF DRY MATTER PER CYLINDER FOR THE COMBINED CROPS—1920.

Table 1

Barley—1920

Series		Nitrogen Applied	DRY MATTER		Nitrogen	NITROGEN			Nitrogen Recovered
			Per Cylinder	Average		Per Cylinder	Average	Increase Over Check	
		gm.	gm.	gm.	per cent	gm.	gm.	gm.	per cent
A	1	....	57.5	....	0.991	0.570	....	....	....
	2	Nothing	53.5	55.5	1.155	0.618	0.594	....	....
	3	....	164.5	....	1.069	1.759	....	....	....
	4	1.54	173.5	169.0	0.861	1.494	1.627	1.033	67.08
	5	....	137.5	....	0.900	1.238	....	....	....
	6	1.54	126.5	132.0	0.900	1.139	1.189	0.595	38.64
B	1	....	67.2	....	1.049	0.705	....	....	....
	2	Nothing	54.0	60.6	1.135	0.613	0.659	....	....
	3	....	155.5	....	0.912	1.418	....	....	....
	4	1.54	179.5	167.5	0.951	1.707	1.563	0.904	58.70
	5	....	132.0	....	0.951	1.255	....	....	....
	6	1.54	129.0	130.5	0.842	1.086	1.171	0.512	33.25
C	1	....	45.5	....	1.135	0.516	....	....	....
	2	Nothing	45.5	45.5	1.088	0.495	0.506	....	....
	3	....	154.7	....	0.873	1.351	....	....	....
	4	1.54	154.6	154.7	0.959	1.483	1.417	0.911	59.16
	5	....	129.5	....	0.900	1.166	....	....	....
	6	1.54	128.6	129.1	0.998	1.283	1.225	0.719	46.69
D	1	....	41.5	....	1.096	0.455	....	....	....
	2	Nothing	48.0	44.8	1.018	0.489	0.472	....	....
	3	....	159.0	....	0.834	1.326	....	....	....
	4	1.54	135.0	147.0	0.920	1.242	1.284	0.812	52.73
	5	....	128.0	....	0.842	1.078	....	....	....
	6	1.54	131.0	129.5	0.802	1.051	1.065	0.593	38.51
E	1	....	44.6	....	1.116	0.498	....	....	....
	2	Nothing	39.5	42.1	1.135	0.448	0.473	....	....
	3	....	154.5	....	0.861	1.330	....	....	....
	4	1.54	139.0	146.8	1.010	1.404	1.367	0.894	58.05
	5	....	108.2	....	1.088	1.177	....	....	....
	6	1.54	112.0	110.1	1.088	1.219	1.198	0.725	47.08
F	1	....	42.5	....	0.979	0.416	....	....	....
	2	Nothing	40.5	41.5	1.018	0.412	0.414	....	....
	3	....	120.5	....	1.011	1.218	....	....	....
	4	1.54	113.5	117.0	1.018	1.155	1.187	0.773	50.18
	5	....	112.0	....	0.744	0.833	....	....	....
	6	1.54	110.0	111.0	0.823	0.905	0.869	0.455	29.55
G	1	....	26.0	....	1.018	0.265	....	....	....
	2	Nothing	25.0	25.5	1.116	0.279	0.272	....	....
	3	....	119.7	....	0.952	1.140	....	....	....
	4	1.54	95.7	107.7	0.932	0.892	1.016	0.744	48.31
	5	....	86.0	....	1.087	0.935	....	....	....
	6	1.54	97.5	91.8	0.960	0.936	0.936	0.664	43.12
H	1	....	27.0	....	1.116	0.301	....	....	....
	2	Nothing	24.0	25.5	1.136	0.273	0.287	....	....
	3	....	70.1	....	1.087	0.762	....	....	....
	4	1.54	110.5	90.3	1.087	1.201	0.982	0.695	45.13
	5	....	91.5	....	1.097	1.004	....	....	....
	6	1.54	94.5	93.0	0.863	0.816	0.910	0.623	40.45

Table 1—Continued

Series		Nitrogen Applied	DRY MATTER		Nitrogen	NITROGEN			Nitrogen Recovered
			Per Cylinder	Average		Per Cylinder	Average	Increase Over Check	
		gm.	gm.	gm.	per cent	gm.	gm.	gm.	per cent
I	1	....	19.0	....	1.087	0.207	....	....	....
	2	Nothing	19.0	19.0	1.167	0.222	0.215	....	....
	3	....	65.5	....	0.991	0.649	....	....	....
	4	1.54	85.5	75.5	0.999	0.854	0.752	0.537	34.87
	5	....	73.5	....	0.921	0.677	....	....	....
	6	1.54	74.0	73.8	0.852	0.630	0.654	0.439	28.51
J	1	....	7.5	....	1.332	0.099	....	....	....
	2	Nothing	7.0	7.3	1.244	0.087	0.093	....	....
	3	....	10.8	....	1.283	0.139	....	....	....
	4	1.54	10.0	10.4	1.234	0.128	0.131	0.038	2.47
	5	....	54.5	....	1.058	0.577	....	....	....
	6	1.54	31.5	43.0	1.077	0.339	0.458	0.365	32.70
Average	1	....	....	....	....	....	....	....	....
	2	....	36.7	....	1.087	0.399	....	....	....
	3	....	....	....	....	....	....	....	....
	4	....	118.6	....	0.955	1.133	....	0.734	47.66
	5	....	....	....	....	....	....	....	....
	6	....	104.4	....	0.927	0.968	....	0.569	36.95

Table 2

Residual Crop of Buckwheat and Summary for Both Crops, 1920

Series		DRY MATTER		Nitrogen	NITROGEN			Nitrogen Recovered	Total Dry Matter	SUMMARY FOR BOTH CROPS		
		Per Cylinder	Average		Per Cylinder	Average	Increase Over Check			Total Nitrogen	Nitrogen Increase Over Check	Nitrogen Recovered
		gm.	gm.	per cent	gm.	gm.	gm.	per cent	gm.	gm.	gm.	per cent
A	1..	37.5	......	1.12	0.420	......	......	......	......	......	......	......
	2..	38.5	38.0	1.08	0.416	0.418	......	......	93.5	1.012	......	......
	3..	43.0	......	1.09	0.469	......	......	......	......	......	......	......
	4..	48.5	45.8	0.97	0.470	0.470	0.052	3.38	214.8	2.097	1.085	70.45
	5..	67.0	......	1.19	0.797	......	......	......	......	......	......	......
	6..	48.5	57.8	0.98	0.475	0.636	0.218	14.16	189.8	1.825	0.813	52.79
B	1..	46.5	......	1.12	0.521	......	......	......	......	......	......	......
	2..	29.0	37.8	1.00	0.290	0.406	......	......	98.4	1.065	......	......
	3..	47.0	......	1.03	0.484	......	......	......	......	......	......	......
	4..	50.0	48.5	1.19	0.595	0.540	0.134	8.70	216.0	2.103	1.038	67.40
	5..	47.0	......	1.13	0.531	......	......	......	......	......	......	......
	6..	54.3	50.7	1.16	0.630	0.581	0.175	11.36	181.2	1.752	0.687	44.61

Table 2—Continued

Series		DRY MATTER			NITROGEN					SUMMARY FOR BOTH CROPS		
		Per Cylinder	Average	Nitrogen	Per Cylinder	Average	Increase Over Check	Nitrogen Recovered	Total Dry Matter	Total Nitrogen	Nitrogen Increase Over Check	Nitrogen Recovered
		gm.	gm.	per cent	gm.	gm.	gm.	per cent	gm.	gm.	gm.	per cent
C	1..	30.0	......	1.05	0.315	......	......	......	......	......	......	......
	2..	31.0	30.5	1.10	0.341	0.328	......	......	96.0	0.834	......	......
	3..	38.0	......	1.12	0.426	......	......	......	......	......	......	......
	4..	42.8	40.4	0.82	0.351	0.389	0.061	3.96	195.1	1.806	0.972	63.11
	5..	46.8	......	1.19	0.557	......	......	......	......	......	......	......
	6..	57.2	52.0	1.23	0.704	0.631	0.303	19.68	181.1	1.856	1.022	66.36
D	1..	34.0	......	1.30	0.442	......	......	......	......	......	......	......
	2..	38.0	36.0	1.19	0.452	0.447	......	......	80.8	0.919	......	......
	3..	23.5	......	0.99	0.233	......	......	......	......	......	......	......
	4..	45.5	34.5	1.17	0.532	0.383	......	......	181.5	1.667	0.748	48.57
	5..	50.5	......	1.13	0.571	......	......	......	......	......	......	......
	6..	52.0	51.3	1.16	0.603	0.587	0.140	9.09	180.8	1.652	0.733	47.60
E	1..	33.0	......	1.14	0.376	......	......	......	......	......	......	......
	2..	31.5	32.3	1.14	0.359	0.368	......	......	74.4	0.841	......	......
	3..	45.0	......	1.13	0.509	......	......	......	......	......	......	......
	4..	51.3	48.2	1.31	0.672	0.591	0.223	14.48	195.0	1.958	1.117	72.53
	5..	44.4	......	1.06	0.471	......	......	......	......	......	......	......
	6..	61.0	52.7	1.21	0.738	0.605	0.237	15.39	162.8	1.803	0.962	62.47
F	1..	34.5	......	1.19	0.411	......	......	......	......	......	......	......
	2..	39.0	36.8	1.19	0.464	0.438	......	......	78.3	0.852	......	......
	3..	38.2	......	1.21	0.462	......	......	......	......	......	......	......
	4..	53.1	45.7	1.26	0.669	0.566	0.128	8.31	162.7	1.753	0.901	58.51
	5..	55.5	......	1.27	0.705	......	......	......	......	......	......	......
	6..	41.2	48.4	1.09	0.449	0.577	0.139	9.03	159.4	1.446	0.594	38.57
G	1..	21.8	......	1.27	0.277	......	......	......	......	......	......	......
	2..	18.5	20.2	1.19	0.220	0.249	......	......	45.7	0.521	......	......
	3..	16.7	......	1.08	0.180	......	......	......	......	......	......	......
	4..	34.3	25.5	1.19	0.408	0.294	0.045	2.92	133.2	1.310	0.789	51.23
	5..	33.0	......	1.21	0.399	......	......	......	......	......	......	......
	6..	30.0	31.5	1.11	0.333	0.366	0.117	7.60	123.3	1.302	0.781	50.71
H	1..	11.5	......	1.03	0.118	......	......	......	......	......	......	......
	2..	15.8	13.7	1.12	0.177	0.148	......	......	39.2	0.435	......	......
	3..	10.8	......	1.25	0.135	......	......	......	......	......	......	......
	4..	14.9	12.9	1.36	0.203	0.169	0.021	1.36	108.2	1.151	0.716	46.49
	5..	18.0	......	.97	0.175	......	......	......	......	......	......	......
	6..	26.7	22.4	1.00	0.267	0.221	0.073	4.74	115.4	1.131	0.696	45.19
I	1..	6.3	......	1.23	0.077	......	......	......	......	......	......	......
	2..	7.5	6.9	1.38	0.104	0.091	......	......	25.9	0.306	......	......
	3..	7.7	......	1.33	0.102	......	......	......	......	......	......	......
	4..	9.7	8.7	1.39	0.135	0.119	0.028	1.82	84.2	0.871	0.565	36.69
	5..	13.9	......	1.18	0.157	......	......	......	......	......	......	......
	6..	16.7	15.3	1.23	0.205	0.181	0.090	5.84	89.1	0.835	0.529	34.35
J	1..	2.5	......	1.61	0.040	0.058	......	......	10.9	0.151	......	......
	2..	4.7	3.6	1.61	0.076	......	......	......	......	......	......	......
	3..	2.0	......	1.59	0.032	......	......	......	......	......	......	......
	4..	2.5	2.3	1.61	0.040	0.036	......	......	12.7	0.167	0.016	1.04
	5..	12.2	......	1.55	0.189	......	......	......	......	......	......	......
	6..	3.0	7.6	1.56	0.047	0.118	0.060	3.90	50.6	0.576	0.425	27.60
Average	1..	......	......	......	......	......	......	......	......	......	......	......
	2..	25.6	......	1.152	.295	......	......	......	62.31	0.694	......	......
	3..	......	......	......	......	......	......	......	......	......	......	......
	4..	31.3	......	1.137	.356	......	0.061	3.96	149.84	1.488	0.794	51.56
	5..	......	......	......	......	......	......	......	......	......	......	......
	6..	39.0	......	1.154	.450	......	0.155	10.06	148.35	1.418	0.724	47.01

Table 3

Average Yield of Dry Matter and Percentage of Nitrogen Recovered from Soils Varying in Mechanical Composition, 1911-20

YEAR	Average Yield of Dry Matter			Nitrogen Recovered	
	Check	Nitrate of Soda	Dried Blood	Nitrate of Soda	Dried Blood
	gm.	gm.	gm.	per cent	per cent
1911	174.1*	297.3*	260.7*	38.9*	24.3*
1912	49.5	89.7	112.7	35.3	38.8
1913	54.1	96.3	99.2	41.8	38.2
1914	55.4	125.3	114.2	64.4	55.0
1915	50.1	127.4	115.9	57.0	49.6
1916	53.5	151.3	126.7	60.2	47.5
1917	68.9	166.8	124.8	62.3	41.6
1918	69.6	167.3	138.0	53.3	44.2
1919	52.9	119.5	105.0	48.3	37.6
1920	62.3	149.8	143.4	51.6	47.0
Average	57.4	132.6	120.0	52.7	44.4

*Omitted from average (Corn grown in 1911).

Table 4

Nine-Year Average Yield of Dry Matter and Nitrogen Recovery for Each of the 10 Soil Mixtures

Soil Mixture	Series	Yield of Dry Matter			Nitrogen Recovery	
		Check	Nitrate of Soda	Dried Blood	Nitrate of Soda	Dried Blood
		lbs.	lbs.	lbs.	per cent	per cent
Loam Soil	A	81.4	157.0	147.9	56.38	46.18
10% sand	B	89.3	164.5	149.9	52.75	42.89
20% sand	C	70.5	152.4	135.6	58.11	47.65
30% sand	D	68.6	156.4	137.2	59.70	47.52
40% sand	E	65.4	153.3	130.7	62.05	47.54
50% sand	F	68.6	152.1	126.8	58.15	40.39
70% sand	G	46.1	134.9	110.5	59.70	45.55
80% sand	H	42.0	110.5	107.7	47.12	47.14
90% sand	I	27.9	97.8	88.3	47.44	42.39
100% sand	J	16.3	47.2	65.0	25.49	36.41
Average		57.6	132.6	120.0	52.69	44.36

For comparison the 9-year averages for the 10 different soil mixtures are shown in table 4.

From this it will be seen that the 10 per cent sand mixture gave the highest average yield, though not the highest nitrogen recovery.

It is of especial interest to note that the yield and nitrogen recovery show but little decline up to and including the 50 per cent sand mixture. The yields from the 40 and 50 per cent sand mixtures are almost as large as the yields from the loam soil, though as previously pointed out the percentage of nitrogen in the former is only a little over half as much as in the latter.

It is significant that the nitrate of soda should show a 9-year average recovery of 47 per cent in the 80 and 90 per cent sand mixtures. For the 80 per cent mixture it stands on a level with the dried blood, and for the 90 per cent mixture it exceeds the latter by 5 per cent. It suggests that even in quite sandy soil the nitrate may be used to as good advantage as the organic sources of nitrogen if crops are kept on the land to fully utilize the nitrogen.

The average yields of dry matter for the combined crops for all series, covering the years 1912 to 1920, are shown by curves in figure 3.

Nitrogen Content of the Soil

With the completion of the work on this project samples of soil were collected from all cylinders and these were dried and prepared for analysis. The samples were collected by taking 5 or 6 cores to the depth of 6¾ inches from each cylinder. These cores were mixed to form a composite sample. Nitrogen determinations were made in duplicate by the Kjeldahl method. Since the treatment is in duplicate there are thus four determinations representing each treatment.

The results are shown in table 5.

For series *A* the percentage of nitrogen is very nearly the same for the three treatments.

For the remaining series the percentage is, in most cases, slightly higher for the nitrogen-treated cylinders than for the check cylinders. With slight exception the agreement between results for the duplicate cylinders is remarkably close. Starting with about 0.1 per cent nitrogen in the loam soil there is a gradual decrease as the percentage of sand in the mixture is increased, until with 100 per cent sand the percentage of nitrogen is approximately one-tenth the amount found in the loam soil.

It is of interest to note that in series *F*—one-half sand and one-half loam soil—the percentage of nitrogen is only a little over half the amount found in series *A*, while the yield of dry matter from *F* in 1920 was more than three-fourths the amount produced by *A*. In 1913 and 1914 the combined yields on F were more than the combined yields on *A*.

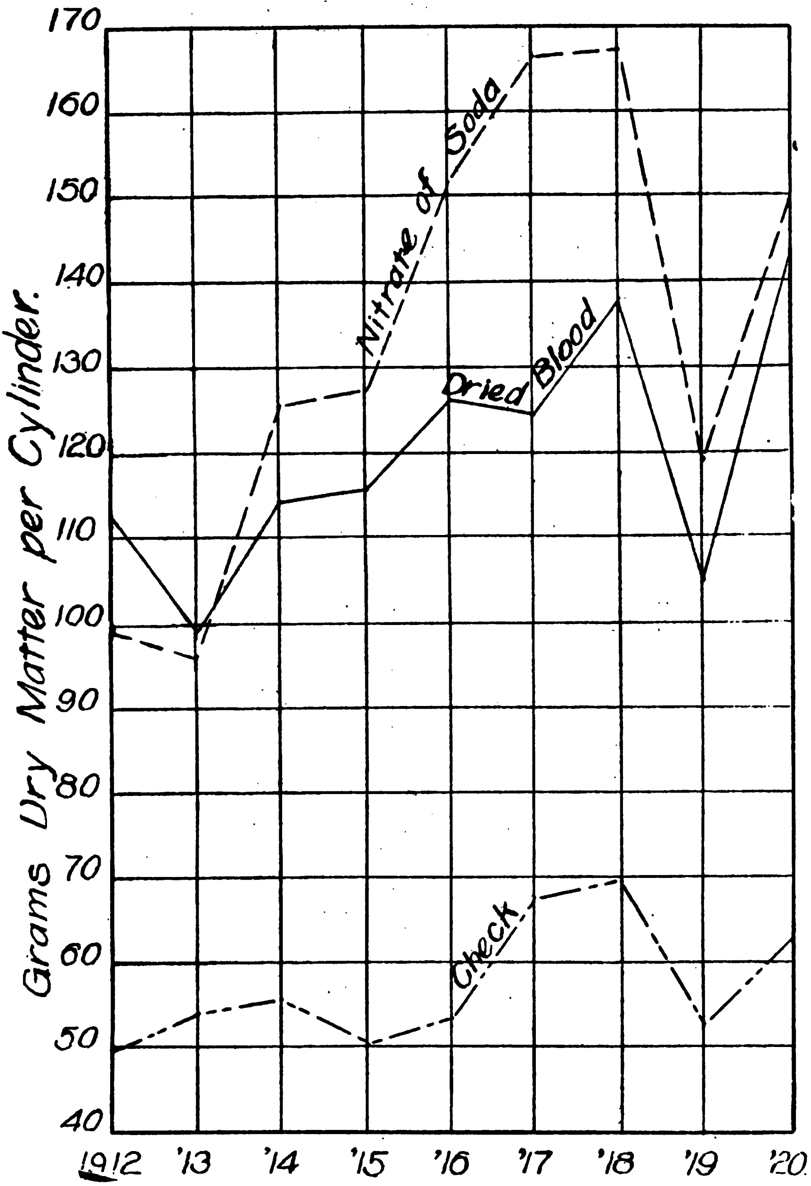

FIG. 3. AVERAGE WEIGHT OF DRY MATTER PER CYLINDER FOR THE COMBINED CROPS—1912-1920.

Table 5

Percentage of Total Nitrogen in Cylinder Soils of Varying Mechanical Composition

	A Loam Soil	B 10% Sand	C 20% Sand	D 30% Sand	E 40% Sand	F 50% Sand	G 70% Sand	H 80% Sand	I 90% Sand	J 100% Sand	Average
	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent
Check	.1133	.0895	.0764	.0674	.0624	.0567	.0293	.0248	.0154	.0088	.0545
Cylinders	.1073	.0904	.0822	.0671	.0611	.0599	.0306	.0232	.0163	.0098	.0548
Nitrate of Soda	.1103	.0982	.0841	.0704	.0662	.0595	.0325	.0249	.0170	.0095	.0573
Cylinders	.1120	.0977	.0854	.0706	.0657	.0621	.0339	.0254	.0192	.0118	.0584
Dried Blood	.1049	.0983	.0860	.0758	.0655	.0611	.0404	.0293	.0197	.0090	.0590
Cylinders	.1049	.0945	.0825	.0794	.0707	.0657	.0359	.0320	.0204	.0095	.0596
Average	.1088	.0947	.0828	.0718	.0653	.0608	.0338	.0266	.0180	.0097	.0572

In a general way these results confirm work reported by Hilgard (1, p. 351) a number of years ago, and illustrate in a striking manner, as he points out, "the impossibility of judging correctly of a soil's productiveness from the *percentage* of chemical ingredients alone."

The physical character of the land must be taken into consideration, since in the lighter soils, the roots have a greater feeding range, and may actually be brought into contact with more plant-food and water than the roots of plants growing in a soil which has a higher percentage of plant-food, but which on account of its heavy nature allows less root development. But there is a limit beyond which greater perviousness and root development cannot make up for a further reduction in the percentage of plant-food in the soil. This is well illustrated in the 80-100 per cent sand cylinders of our experiment. There finally comes a point where the soil can hold but little plant-food and moisture, and this in itself becomes a limitation on further root development. In such soils (sands) crops can be grown only to advantage when water and available plant-food are supplied in optimum amounts.

Summary

For 10 years nitrate of soda and dried blood, furnishing equivalent amounts of nitrogen, have been compared in the growing of crops in cylinders containing soils varying in mechanical composition from a loam to a coarse sand.

With the exception of the first year—1911—two crops have been grown each year but the fertilizers have always been applied to the first crop, the second crop being grown as a residual crop to utilize any nitrogen left after the growing of the first crop.

Mineral fertilizers and lime have been applied to all cylinders in liberal amounts so that these have not been limiting factors.

With the exception of 1911, when corn was grown, the first crop has always been barley, and with one exception the second has always been buckwheat. During the last 4 or 5 years of the experiment rye has been seeded as a winter cover crop.

With the exception of the 80-100 per cent sand series the crop yields and the nitrogen recovery have usually been in favor of the nitrate of soda. In a few cases even the 80 per cent sand mixture has yielded more with nitrate than with blood.

Neither the nitrate nor the blood has shown high residual effects, but the blood has usually surpassed the nitrate in the case of crops grown for the residual effect. However, the initial effect of the nitrate has usually been sufficiently in advance of the initial effect of the blood to carry the total effect of the former beyond that of the latter, except in the case of the 80-100 per cent sand series, reference to which has already been made.

The reason for the superiority of the nitrate over the blood seems to be its ability to give the plant a good start during its early growth.

With such a start it is enabled better to utilize soil moisture and the natural plant-food of the soil than the plant which, on account of having a slowly available source of nitrogen, gets a slow start. This interpretation seems to be borne out by the fact that in some cases the check cylinders gave a larger residual crop than the nitrate cylinders.

It has been quite common to regard the organic sources of nitrogen as having a more permanent and lasting effect than the mineral sources, the latter having been regarded as subject to rather rapid loss through leaching. The results of this experiment do not bear out this idea, except in the case of soils which are almost pure sand. It would appear that the young growing plant rapidly utilizes the nitrogen of soluble nitrates and thus forges ahead of the plant which is depending upon sources not so readily available. It is possible that during the transformation of the nitrogen of these slowly available materials into soluble forms there is a considerable loss.

References

(1) Hilgard, E. W. 1906. Soils.
(2) Lipman, J. G., and Blair, A. W. 1916. Investigations relative to the use of Nitrogenous Plant-Foods, 1898-1912. N. J. Agr. Exp. Sta. Bul. 288.

THE CONTINUOUS GROWING OF WHEAT AND RYE WITH AND WITHOUT A LEGUME AS A GREEN-MANURE CROP—SEASON 1920

The plots involved in this experiment have been kept in wheat and rye year after year since 1909.

Each year one rye plot and one wheat plot—Nos. 70 and 71, respectively— are seeded to soybeans immediately after harvesting the grain. The soybeans are allowed to grow until two or three weeks before wheat-seeding time—about the middle of September—when they are plowed under as a green-manure crop. In the meantime the other rye and wheat plots remain in stubble. The two legume plots get such an amount of nitrogen as a crop of soybeans growing for about 60 days can accumulate, and two others go from year to year without any applied nitrogen.

It should be explained here, however, that for two or three years volunteer clover has been creeping in on these non-legume plots during the summer, and this has had a distinctly favorable influence on yields from these plots. They are thus obtaining nitrogen which they are not supposed to have, and this added nitrogen becomes a disturbing factor in the experiment. Such influence might be largely avoided by plowing the land immediately after harvest and keeping it cultivated during summer. While such a course would be advisable in the case of experimental work, it would be entirely unnecessary in general practice, since the presence of the clover, under such conditions, would be an advantage.

All plots receive liberal applications of acid phosphate and muriate of potash annually and are limed once in 5 years.

Crop of 1920-21

After harvesting the grain in 1919 plots 70 and 71 were disked and seeded to Ito San soybeans. Abundant rains followed and a good stand of beans was secured. By September 17 when the land was plowed the beans were nearly 2 feet high and showed excellent inoculation. The ground was prepared, mineral fertilizers applied as in former years, and on October 4 wheat and rye were seeded on the respective plots at the rate of about 7 pecks per acre.

The crops made normal growth during the fall and came through the winter in fair condition, although the wheat was thin in some spots on account of slight winter killing.

The grain was harvested and weighed July 6 and samples prepared for analysis in the usual way. The yields of grain, straw, and total nitrogen are reported in table 6.

From this table it will be noted that the yield of rye grain on plot 70 is slightly more than double the yield on No. 68—the corresponding plot without the legume crop. Also, the straw on plot 70 is practically double that on plot 68. The total nitrogen for the latter is 24.4 pounds and on the former 53.2 pounds per acre. The increase in the yield on the legume wheat plot, over the yield on the non-legume plot is not so great as in the case of the rye, but it amounts to nearly 8 bushels per acre, and the yield of straw was a little more than doubled. The yield of nitrogen on the non-legume wheat plot was 19.4 pounds and on the legume plot 35.5 pounds per acre.

The legume rye plot gave an increase amounting to 17.7 bushels of grain and 2,328 pounds of straw per acre, and the legume wheat plot an increase amounting to 7.9 bushels of grain and 1,384 pounds of straw per acre.

The increase in yield of nitrogen with the wheat is equivalent to 100 pounds of nitrate of soda and the increase with the rye to nearly 200 pounds of nitrate of soda. The differences undoubtedly would have been for the good stand of volunteer clover on plots 68 and 69, reference to which has already been made.

The value of the legume is undoubtedly more than is represented by increases in yield since it is at the same time greatly increasing the amount of organic matter in the soil.

Table 6

Rye and Wheat Grown With and Without a Legume Green-Manure Crop—Season 1920 (Calculated to Acre Basis)

Plot No.	Crop	Grain			Straw			Total Nitrogen
		Dry Matter	Nitrogen		Dry Matter	Nitrogen		
		lbs.	per cent	lbs.	lbs.	per cent	lbs.	lbs.
68	Rye alone	924	1.81	16.7	2396	.322	7.7	24.4
70	Rye followed by soybeans	1916	1.96	37.5	4724	.334	15.8	53.3
69	Wheat alone ..	644	2.10	13.5	1356	.434	5.9	19.4
71	Wheat followed by soybeans..	1120	2.16	24.2	2740	.414	11.3	35.5

THE CONTINUOUS GROWING OF CORN WITH A LEGUME AND A NON-LEGUME GREEN-MANURE CROP, SEASON 1920

With the exception of one year—1910, when oats was seeded—corn has been grown on eight 1/20-acre plots continuously since 1908. Each year at or about the time of the last cultivation of the corn four of the plots are seeded to a legume cover crop, vetch and a mixture of clovers, and four to a non-legume, rye.

To three plots of both sections small amounts of manure are added annually for the purpose of introducing bacteria and other organisms into the soil. The manure is used with the thought that the organisms thus introduced into the soil may hasten the decomposition of the organic matter, and therefore aid in the formation of available plant-food. If this assumption is correct, then the manure-treated plots should furnish more available plant-food than the check plots and this should be reflected in the better growth of crops. The amount of the manure is purposely kept small so that the fertilizer constituents may not have an important influence. It is true that the increased amount of plant-food carried in the larger applications of manure might account in part at least, for the increase in yield on these plots, but since phosphoric acid and potash are used in liberal amounts, it is believed that the amount of these materials carried in the manure would not have an appreciable effect on the yields.

The results for the years 1908 to 1919, inclusive, have appeared in earlier reports. The results for the season of 1920 are herewith reported in table 7.

The Legume and the Non-Legume Sections Compared

The yields from the legume section are distinctly larger than those from the non-legume section, the average yield of shelled corn for the four plots of the former being 2,731 pounds per acre, and of the latter 1,859 pounds.

This gives the legume section the advantage by about 15½ bushels of shelled corn per acre. The difference in yield of stover is only slightly in favor of the legume section.

The yield of nitrogen of the legume section is, on an average, about 20 pounds in excess of the yield of the non-legume section. During the growing period the influence of the legume on the corn was very noticeable both in a more vigorous growth and also in a darker color. The percentage of nitrogen is higher in both grain and stover from the legume section than from the non-legume section.

The Influence of the Manure

In each section the manure-treated plots have yielded more dry shelled corn than the corresponding check plot, the widest difference in the legume section being 392 pounds, and in the non-legume section 444 pounds. As previously suggested it is possible that this increase may be due in part to the gradually increasing amounts of manure, though it seems probable that the inoculating effect of the manure also has a bearing upon this increase.

The results with the legume present a strong argument in favor of this kind of cover crop rather than the non-legume, wherever conditions will permit. In this connection it may be suggested that sweet clover appears to be one of the hardiest of the legume crops and is therefore well adapted for this purpose.

Table 7
Continuous Corn with Legume and Non-Legume Cover Crop, 1920
(Calculated to Acre Basis)

Number	SPECIAL TREATMENT	GRAIN			COBS			STALKS			Total Stover	Total Nitrogen	INCREASE OVER CHECK		
		Dry Matter	Nitrogen	Nitrogen	Dry Matter	Nitrogen	Nitrogen	Dry Matter	Nitrogen	Nitrogen			Grain	Stover	Nitrogen
							LEGUME SECTION								
		lbs.	per cent	lbs.	lbs.	per cent	lbs.	lbs.	per cent	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
49	No manure	2596	1.278	33.18	500	0.426	2.13	2700	0.926	25.00	3200	60.31	......	......	......
50	50 lbs. manure	2640	1.296	34.21	544	4.444	2.42	3052	0.889	27.13	3596	63.76	44	396	3.45
51	100 lbs. manure	2700	1.270	34.29	572	0.548	3.13	3328	0.733	24.39	3900	61.81	104	700	1.50
52	200 lbs. manure	2988	1.344	40.16	604	0.426	2.57	3684	0.696	25.64	4288	68.37	392	1088	8.06
	Average	2731	1.297	35.46	555	0.461	2.56	3191	0.811	25.54	3746	63.56	180	728	4.34
							NON-LEGUME SECTION								
53	No manure	1696	1.233	20.91	324	0.370	1.20	3136	0.574	18.00	3460	40.11	......	......	......
54	50 lbs. manure	1776	1.185	21.05	344	0.630	2.17	2856	0.611	17.45	3200	40.67	80	loss	0.56
55	100 lbs. manure	1824	1.185	21.61	348	0.678	2.36	2852	0.704	20.08	3200	44.05	128	loss	3.94
56	200 lbs. manure	2140	1.259	26.94	352	0.622	2.19	3420	0.759	25.96	3772	55.09	444	312	14.98
	Average	1859	1.216	22.63	342	.575	1.98	3066	0.662	20.37	3408	44.98	217	loss	6.49

THE INFLUENCE OF LIME ON THE YIELD AND NITROGEN CONTENT OF SOYBEANS— SEASON 1920

With the crop of 1920, soybeans have now been grown continuously on limed and unlimed plots for a period of 8 years. The plots vary in size from 1/20 to 1/80 acre. Finely ground limestone has been applied to certain of the plots at intervals of 5 years, beginning in 1908. The initial application was at the rate of 1 ton per acre. Subsequent applications have been at the rate of 2 tons per acre. Other plots have remained unlimed since 1908, and these had probably not received any lime for a number of years preceding that date. Acid phosphate and muriate of potash have been used in liberal amounts so that these may not become limiting factors.

Six varieties of beans were grown on limed plots, and on corresponding unlimed plots during the season of 1920. Eleven other varieties were grown on limed plots only. The beans were grown to maturity and harvested and threshed for seed.

The results for the 1920 crop are reported in table 8.

The yields on the unlimed plots have gradually decreased until this year the average is less than 1 bushel per acre. The yield of dry stalks from the unlimed plots was only about one-tenth the average yield from the limed plots. With slight exception the percentage of nitrogen in beans and stalks from the limed plots is higher than in the beans and stalks from the unlimed plots.

The average total yield of nitrogen returned by beans and stalks from 5 limed plots (one limed plot is omitted from the average) was 71.9 pounds per acre, while the average from six unlimed plots was only 4.83 pounds per acre. The highest acre yield of nitrogen from a limed plot was 89.9 pounds, while the highest from an unlimed plot was only 9.96 pounds. The average yield of shelled beans on the limed plots is approximately fifteen times the average on the unlimed plots. The average yield from eleven varieties grown on limed plots not having corresponding unlimed plots, was 12.4 bushels per acre.

The highest yield of beans in this lot was 17.7 bushels per acre by Manchu, and the highest yield in the other series was 17.8 bushels per acre by Edna, closely followed by Baird with a yield of 17.6 and Wilson with a yield of 17.5.

Conclusion

If phosphoric acid and potash are supplied in reasonable amounts and the soil is kept properly limed and has good drainage, soybeans may be grown year after year on the same land with good success.

Grown in this way the yield of beans is not only much larger than the yield on land deficient in lime but both beans and vines have a higher feeding value on account of their higher content of nitrogen.

Soybeans can thus be made a valuable crop for maintaining the supply of nitrogen and organic matter in the soil.

Soils having a lime requirement of 600 to 800 pounds or more will undoubtedly show a response to lime when soybeans are being grown.

Table 8

The Influence of Lime on the Yield and Nitrogen Content of Soybeans—1920

(Calculated to Acre Basis)

VARIETY	SHELLED BEANS.							STALKS.						TOTAL	
	LIMED			UNLIMED				LIMED			UNLIMED			NITROGEN RECOVERED	
	Dry Beans	Nitrogen		Dry Beans		Nitrogen		Dry Stalks	Nitrogen		Dry Stalks	Nitrogen		Limed	Unlimed
	Bu.	Per cent	Lbs.	Bu.	Lbs.	Per cent	Lbs.	Lbs.	Per cent	Lbs.	Lbs.	Per cent	Lbs.	Lbs.	Lbs.
Baird	17.6	7.049	74.44	1.1	66	6.989	4.61	1326	1.168	15.49	258	1.604	4.14	89.93	8.75
Ebony	10.5	7.100	44.73	0.25	15	6.724	1.01	564	1.041	5.87	33	1.584	0.52	50.60	1.53
Edna	17.8	6.368	68.01	0.7	42	6.415	2.69	1242	0.962	11.95	114	1.426	1.63	79.96	4.32
Minn. No. 115	5.9*	6.652	23.55*	2.3	138	6.435	8.88	306*	0.764	2.34*	144	0.752	1.08	25.89*	9.96
Swan	13.9	6.732	56.14	0.2	12	6.316	0.76	906	0.871	7.89	24	1.386	0.33	64.03	1.09
Wilson	17.5	6.150	64.58	0.65	39	5.821	2.27	1386	0.745	10.33	81	1.327	1.07	74.91	3.34
Average	15.5	6.675	61.58	0.87	52	6.450	3.37	1085	0.925	10.30	109	1.347	1.46	71.9	4.83
Austin	15.5	6.673	62.06					828	0.665	5.51				67.57	
Cloud	15.8	6.486	61.49					1080	0.772	8.34				69.83	
Elton	7.9	7.128	33.79					378	0.764	2.89				36.68	
Haberlandt	11.5	6.684	46.12					762	1.101	8.39				54.51	
Hahto	10.7	6.791	43.60					918	1.081	9.92				53.52	
Ito San	10.6	7.041	44.78					564	0.705	3.98				48.76	
Manchu	17.7	6.692	71.07					804	0.673	5.41				76.48	
Manhattan	9.0	7.147	38.59					570	0.950	5.42				44.01	
Virginia	14.7	6.486	57.21					1008	0.784	7.90				65.11	
Med-Yellow	12.4	6.178	45.96					710	0.752	5.34				51.30	
Ohio 9035	10.53	6.574	41.55					644	1.041	6.70				48.25	
Average	12.39	6.717	49.66					751	.844	6.34				56.00	

*Omitted from average.

REPORT OF THE DEPARTMENT OF PLANT PHYSIOLOGY

Department of Plant Physiology

John W. Shive, Ph.D., *Plant Physiologist.*

Linus H. Jones, M.Sc., *Research Fellow.*

***Elmer L. Sargent, B.Sc.,** *Research Assistant.*

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David Schmidt, B.Sc., *Research Fellow.*

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*Resigned September 1, 1920.
†Appointed September 1, 1920.

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Report of the Department of Plant Physiology

JOHN W. SHIVE, PH.D.

INTRODUCTION

The work of the department of plant physiology followed along the same lines which were pursued during the preceding year. The several active projects upon which the members of the department were engaged have been vigorously prosecuted and very good progress has been made toward the solution of a few physiological problems of a fundamental character.

As before, weekly meetings were held throughout the year by the members of the department for the review of current physiological literature and for the discussion of questions relating to the work of the laboratory. These meetings were well attended and a splendid interest was manifested throughout. A considerable portion of the time of the plant physiologist was devoted to teaching and to graduate-student conference relating to the experimental work. A course of lectures covering the field of plant physiology was offered to the graduate students doing work in the laboratory. Two lectures were given each week throughout two-thirds of the year.

The needs of the department are the same as those mentioned in last year's report but the needs are becoming more and more urgent. The large increase in the number of persons who are engaged in research in the laboratory of plant physiology has rendered the present laboratory space and equipment entirely inadequate. It is hoped and urged that the pressing need for more spacious quarters may be relieved in the near future by the completion of the laboratory building.

In spite of the handicap imposed by the very limited working space and equipment the plant physiologist is pleased to be able to report that fine progress has been made with the problems under investigation.

PERSONNEL

The research assistant, E. L. Sargent, resigned his position early in the year to accept an appointment as instructor in the chemistry department of Rutgers College. To fill the position thus made vacant, Steich Wakabayashi, of the State College of Washington, was appointed. Mr. Wakabayashi assumed the duties of his position on September 1. Linus H. Jones continued his work during the year as the Ammonium Sulfate Research Fellow in plant physiology. Dr. E. Van Alstine was engaged in research under a special fellowship established for the year by the Commonwealth Fertilizer Company of Baltimore, Maryland.

The names of the persons who during the past year did work in the State University of New Jersey leading toward higher degrees and who were registered as graduate students in plant physiology are as follows:

Names of Persons Making Plant Physiology the Major Subject

Linus H. Jones, B.Sc., M.Sc., Massachusetts Agricultural College.
Steich Wakabayashi, B.Sc., M.Sc., State College of Washington.
David Schmidt, B.Sc., Rutgers College.
Robert V. Allison, B.Sc., Purdue University.
Robert M. Barnette, B.Sc., Clemson Agricultural College.
Dorothy Silbert, A.B., Barnard College.

Names of Persons Making Plant Physiology the Subordinate Subject

Joseph R. Neller, A.B., Macalaster College; A.M., University of Minnesota.
Robert F. Poole, B.Sc., Clemson College, M.Sc., Rutgers College.
W. Rudolfs, Graduate in Agriculture, Wagenigen School of Agriculture.
Charles H. Connors, B.Sc., Rutgers College.
Arthur L. Prince, A.B., M.Sc., Massachusetts Agricultural College.
Charles S. Beckwith, B.Sc., Rutgers College.
Dana G. Coe, A.B., Ohio State University.

INVESTIGATION

The research work of the laboratory of Plant Physiology has been continued throughout the year with considerable vigor. The aim of the work, however, has remained the same as before. The studies carried out are not primarily of a practical nature but are designed rather to assist in the preparation of the scientific foundation which is necessary for practical advance along agricultural lines. The year's accomplishment has been fully as large as, and perhaps exceeds that of any previous year.

The investigational work of the department was carried out under the following projects:

1. The salt requirements of representative agricultural plants.
2. The relation of soil moisture content to the physiological value of nutrient mixtures for plants.
3. The relative availability and efficiency of various soluble and insoluble iron compounds in relation to plant production.

4. The study of ammonium sulfate in relation to plant production.
5. A study of plant growth and crop production in relation to size and weight of seed.

The researches carried out during the year under these projects are briefly outlined and described under the titles which appear in the following pages. These brief abstract reports are only preliminary and are not intended to give any detailed account of the work but serve merely to give a brief outline of the experimental procedure and a summary of some of the principal results obtained. A somewhat concrete conception of what has been accomplished during the year may be formed by referring to these preliminary abstract reports.

During the year, various technical papers by members of the staff of the Department of Plant Physiology have been published in scientific journals. They include technical papers Nos. 6, 10, 11, 15 and 21, as listed on page 348.

THE SALT REQUIREMENTS OF THE SOYBEAN PLANT DURING THE SEEDLING PHASE

J. W. Shive, A. L. Prince, R. V. Allison and S. Wakabayashi

A very brief summary is here given of the main results of a study of the salt requirements of the soybean plant in solution cultures during the early stages of growth to the flowering period. The work was carried out with the "Edna" variety of soybeans in that series of culture solutions designated as type I, in a "plan for cooperative research" (1) prepared for a special committee of the National Research Council. The molecular proportions and the partial volume-molecular concentrations of the culture solutions used are there definitely described (p. 30). The methods of solution culture work set forth in this plan for cooperative research was here followed out in every detail except that ferrous sulfate in quantities of 1 mgm. of iron per liter of nutrient solution was used instead of the prescribed small trace of ferric phosphate. A description of the methods employed in this work, therefore, are omitted.

Three complete series of 21 cultures each were conducted simultaneously during a period of 35 days from February 1, to March 7, 1921. For the sake of brevity only those cultures which produced the highest seven yields of tops and roots will here be considered. Since the three series conducted simultaneously were in very good agreement with respect to the general appearance of the plants and the relative yield data obtained, only the averaged data will be given. The numerical yield data for the cultures producing the highest seven yields of tops and of roots together with the partial volume-molecular concentrations of the corresponding culture solutions are presented in table 1. The relative yield values of tops and of roots as given in the table are plotted on the triangular diagram of figure 1.

The distribution in the series of the cultures producing the highest seven yields of tops is indicated on the triangle by the stippled area while the distribution of the cultures producing the highest seven root yields is similarly represented by the dotted area.

Table 1

The highest seven average absolute and relative dry-weight yields of soybean tops and roots grown to the flowering stage (first 5 weeks) in 3-salt solutions of type I; also the volume-molecular partial concentrations of the corresponding solutions

Culture number	Volume-molecular partial concentrations			Dry weight, average for 3 cultures			
				Absolute		Relative to R_1C_1 as 1.00	
	KH_2PO_4	$Ca(NO_3)_2$	$MgSO_4$	Tops	Roots	Tops	Roots
				gm.	gm.		
R_1C_1	0.0027	0.0027	0.0161	2.9455	0.4178	1.00	1.00
R_1C_2	0.0025	0.0049	0.0123	2.8671	0.3897	0.98	0.92
R_1C_3	0.0024	0.0071	0.0094	2.6973	....	0.92	....
R_2C_1	0.0053	0.0027	0.0132	2.9332	0.4250	1.00	1.01
R_2C_3	0.0047	0.0071	0.0071	2.8122	0.3539	0.94	0.83
R_3C_1	0.0076	0.0025	0.0101	....	0.3783	....	0.89
R_3C_2	0.0072	0.0048	0.0072	2.6357	0.4112	0.90	0.76
R_4C_1	0.0099	0.0025	0.0074	2.5731	0.3508	0.87	0.82
*Check	0.0180	0.0052	0.0150	3.1378	0.4386	1.07	1.06

*In all cases Shive's solution No. R_5C_2 at 1.75 atmospheres was used as a control.

From an examination of the areas of high top yields and high root yields it is at once apparent that the area of high root yields is largely included in that of high top yields thus indicating that there is a marked degree of correlation between the growth of tops and of the roots of these plants. Out of a group of seven cultures which produced high yields of tops, six produced also high root yields and these six cultures are included in the area representing high top yields and also in that representing high root yields on the triangular diagram of figure 1.

The maximum yield of tops was produced by culture R_1C_1 which produced also the next to the highest root yield. The three salts KH_2PO_4, $Ca(NO_3)_2$, and $MgSO_4$ were present in this culture in the molecular proportions of 1:1:6. The maximum yield of roots and the next to the hightest yield of tops were produced by culture R_2C_1 in which the salts KH_2PO_4, $Ca(NO_3)_2$, and $MgSO_4$ were present in the proportions of 2:1:5. As shown in table 1 corresponding yields from these two cultures (R_1C_1 and R_2C_1) are nearly equal in value, the former showing a very slight superiority over the latter in top yields and the latter being slightly superior to the former with respect to the yield of roots. It will be observed, however, that the maximum yield of both tops and roots is slightly surpassed by the corresponding average yield from the check cultures (Shive's R_5C_2).

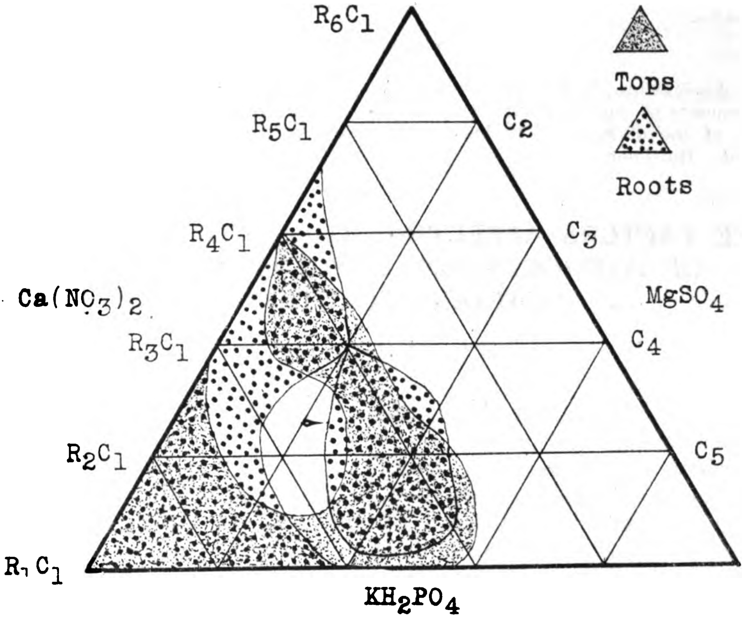

FIG. 1. DIAGRAM SHOWING THE POSITION IN THE SERIES OF THE CULTURES PRODUCING THE HIGHEST SEVEN YIELDS OF SOYBEAN TOPS AND ROOTS. MAXIMUM YIELD OF TOPS PRODUCED BY CULTURE R_1C_1, THAT OF ROOTS BY CULTURE R_2C_1.

The position of the shaded areas on the triangular diagram of figure 1 and the data of table 1 show that the cultures producing the highest seven yields cover medium ranges in the molecular proportions of all three salts when compared with the total ranges of the salts for the entire series. These ranges include the lowest proportions of KH_2PO_4 and $Ca(NO_3)_2$ and the highest proportions of $MgSO_4$ and extend from 0.0024 to 0.0099, from 0.0025 to 0.0071, and from 0.0071 to 0.0161, respectively. The maximum yields of tops and roots, however, are definitely associated with the lowest proportions of KH_2PO_4 and $Ca(NO_3)_2$. and with the highest proportions of $MgSO_4$.

It is interesting here to note that all the cultures which produced low yields of either tops or roots are characterized by having high proportions of $Ca(NO_3)_2$ and correspondingly low ones of $MgSO_4$. These cultures are located on the right margin of the triangular diagram and include the entire range in the proportions of KH_2PO_4. It thus appears that $Ca(NO_3)_2$ and $MgSO_4$ are the determining factors in the production of either high or low yields, and that KH_2PO_4 has much less influence upon the growth rates of soybean plants during the early stages of development than has either of the other two salts.

Reference

(1) Livingston, B. E. 1919. A plan for cooperative research on the salt requirements of representative agricultural plants prepared for a special committee of the division of Biology and Agriculture of the National Research Council. Baltimore.

SOME FACTORS AFFECTING THE RATE OF CHANGE OF HYDROGEN--ION CONCENTRATION IN NUTRIENT SOLUTIONS

L. H. JONES

It is well known that the hydrogen-ion concentration of nutrient solutions is markedly altered by growing plants. The experiments here briefly summarized were carried out for the purpose of studying the influence of total concentration, volume of solution, and varying numbers of plants upon the rate of change of the hydrogen-ion concentration of the nutrient medium in contact with the roots of growing plants.

The influence of both soybean and wheat plants was studied, but since the results obtained with both species are very similar only those for wheat will be presented. Wheat was grown in Shive's solution R_5C_2 with total osmotic concentration values of 0.10, 1.75 and 2.50 atmospheres. Table 1 gives the volume-molecular partial concentrations of this solution corresponding to the total osmotic concentrations employed.

The plants were grown in quart fruit jars under the cultural methods described by Shive (3) and the studies on the rates of change of the hydrogen-ion concentrations were not begun until the plants were between 4 and 5 weeks old. As a source of iron for the plants ferrous sulfate in quantities of 1 mgm. of iron per liter of nutrient solution was added to the cultures containing 6 plants or less, and 2 mgm. of iron per liter was added to the cultures comprising more than 6 plants. This was found necessary in order to prevent chlorosis in the plants.

The hydrogen-ion concentrations recorded in table 2 in terms of pH values were determined by the colorimetric method, using the indicators of Clark and Lubs (1) and the double tube standards of Gillespie (2), being used. Readings were taken every 2 hours except in the solutions having the lowest concentration in which the reaction change was very rapid and with these solutions readings were taken at 15-minute intervals. The data presented are for the day readings only. The work was duplicated during the night and practically the same results were obtained as during the day. The rate of reaction change was very slightly less during the night, which condition may be accounted for by the lower temperature during the night hours.

Table 1

Volume-Molecular Partial Concentrations of Shive's Solution R_5C_2 Corresponding to Three Different Total Osmotic Concentrations

Osmotic Concentration	Volume-molecular Partial Concentrations		
	KH_2PO_4	$Ca(NO_32)_2$	$MgSO_4$
atmospheres 1.00	0.00103	0.00030	0.00086
1.75	.0180	.0052	.0150
2.50	.0257	.0074	.0214

In table 2 is given a summary of the hydrogen-ion concentration readings, in terms of pH values, of the nutrient solutions in contat with the roots of 2, 6, and 12 plants in three different volumes of the solution, each volume being employed with three different total osmotic concentration values. The results of the tests as indicated by the data may be expressed briefly as follows:

(1) With each number of plants used in a given volume of nutrient solution the rate of change of the hydrogen-ion concentration decreased with an increase in the total osmotic-concentration value of the solution.

(2) With each number of plants grown in the nutrient solution having a given total osmotic-concentration value the rate of change of the hydrogen-ion concentration decreased with each increase in the volume of the solution.

(3) With each volume of nutrient solution and with each total osmotic concentration the rate of change of the hydrogen-ion concentration increased with each increase in the number of plants grown in the solution.

Table 2

The Effect of Varying the Numbers of Plants, Different Total Concentrations, and Different Volumes of a Nutrient Solution, Upon the Rate of Change of the Hydrogen-ion Concentration

Total concentration	Time	500 cc. of solution			900 cc. of solution			2600 cc. of solution		
		Number of plants			Number of plants			Number of plants		
		2	6	12	2	6	12	2	6	12
(atm.)	hr.	pH	pH	pH	pH	pH	pH	pH	pH	*pH*
0.10	0.00	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
	0.25	4.9	5.0	5.5	4.9	5.0	5.1	4.9	5.0	5.1
	0.50	5.2	5.2	5.6	5.0	5.1	5.5	5.0	5.1	5.3
	0.75	5.4	5.5	5.9	5.2	5.2	5.5	5.1	5.2	5.3
	1.00	5.4	5.5	6.0	5.2	5.3	5.5	5.2	5.3	5.3
	1.25	5.5	5.5	6.0	5.2	5.3	5.6	5.2	5.3	5.3
	1.50	5.5	5.6	6.0	5.4	5.5	5.7	5.2	5.3	5.3
	1.75	5.6	5.7	6.2	5.4	5.5	5.8	5.3	5.3	5.3
	2.00	5.7	5.8	6.2	5.4	5.6	5.8	5.3	5.3	5.3
	12.00	.....	.....	.....	6.0	6.1	6.3	.....	.....	.....
1.75	0.00	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
	2.00	4.5	4.7	5.1	4.5	4.5	4.7	4.5	4.5	4.5
	4.00	4.8	5.0	5.3	4.7	4.8	5.1	4.6	4.6	4.7
	6.00	4.9	5.3	5.3	4.8	5.0	5.3	4.6	4.7	4.8
	8.00	5.0	5.4	5.6	4.9	5.1	5.4	4.7	4.9	4.9
	10.00	5.1	5.5	5.9	5.0	5.3	5.6	4.8	4.9	5.1
2.50	0.00	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
	2.00	4.5	4.6	4.9	4.5	4.5	4.6	4.3	4.4	4.4
	4.00	4.7	4.8	5.1	4.5	4.7	4.8	4.4	4.5	4.5
	6.00	4.8	4.9	5.3	4.6	4.8	4.9	4.4	4.5	4.6
	8.00	4.9	5.0	5.4	4.6	4.9	5.0	4.5	4.6	4.7
	10.00	4.8	5.2	5.5	4.7	5.0	5.2	4.6	4.7	4.9

The maximum rate of change of the hydrogen-ion concentration of the nutrient solution in contact with the plant roots occurred very soon after the plant roots were brought in contact with the solution. The rate of reaction change then gradually decreased until the maximum change which the plants were capable of producing in the solution employed had been reached. The wheat plants here used grown in Shive's 3-salt solution R_5C_2 changed the hydrogen-ion concentration of the solution from the initial pH values of 4.9, 4.5, and 4.3, corresponding to osmotic-concentration values of 0.1, 1.75, and

2.50, respectively, to a pH value slightly below the neutral point. The time required to produce the maximum change, however, was different for each number of plants, for each total concentration, and for each volume of the nutrient solution employed.

References

(1) Clark, W. M., and Lubs, H. A. 1917. The colorimetric determination of hydrogen-ion concentration and its application to bacteriology. *In* Jour. Bact., v. 2, p. 1-34; 109-136; 191-236.

(2) Gillespie, L. J. 1920. Colorimetric determination of hydrogen-ion concentration without buffer mixtures, with especial reference to soils. *In* Soil Sci., v. 9, p. 115-136.

(3) Shive, J. W. 1915. A study of physiological balance in nutrient media. *In* Physiol. Res., v. 1, p. 327-397.

RELATION OF SEED WEIGHT TO THE RATE OF GROWTH AND SIZE OF CRIMSON CLOVER PLANTS

DAVID SCHMIDT

In order to secure data on the relation of seed weight to plant growth a series of experiments have been planned. The following report presents a part of the work thus far carried out but this is only preliminary to the main series of experiments.

Seeds of a commercial strain of crimson clover were selected and weighed accurately to the tenth of a milligram and were then planted in well mixed, screened compost soil 5 inches deep in flats 15 inches wide and 18 inches long. Three grades of seeds with respect to weight were planted, five seeds of each grade in each of three flats. The weights of the individual seeds in the different grades were 2.0 mgm., 3.5 mgm., and 5.0 mgm.

The seeds were planted February 1, and germination counts were made February 4. These counts were continued twice daily until February 7. Out of the 15 seeds of each grade planted 8 of the 2.0-mgm. grade, 14 of the 3.0-mgm. grade, and 13 of the 5.0-mgm. grade germinated. Observations made twice daily showed that the heavier seeds germinated earlier than did those of lighter weight. Similar observations were made from February 9 to February 12 on the formation of the first foliage leaves, which in the crimson clover consist of single leaflets. The observations showed that the first appearance of these leaves followed the same order as did the germination of the seeds, the plants from the heavier seeds producing the leaves earlier than those from the lighter-weight seed. This is clearly shown by the data of table 1. It is interesting to note that the germination and the formation of first foliage leaves of soybeans and buckwheat, the growth measurements of which cannot here be reported, proceed in the reverse order from that of the crimson clover.

Table 1

Number of First Foliage Leaflets Formed by Crimson Clover Plants Grown from Seeds of Different Weights

Dates of observation	Number of plants with first leaflets formed		
	2.0-mgm. seeds	3.5-mgm. seeds	5.0-mgm. seeds
February 9	0	1	9
February 10	1	8	10
February 11	4	11	11
February 12	8	13	11

From table 1 it will be observed that the first foliage leaves of the plants from the heaviest seed had nearly all been formed before any appeared on the plants from the lightest seed. The plants from the medium-weight seed developed the first foliage leaves earlier than did those from the lightest seed and somewhat later than those from the heaviest seeds. It is thus apparent that during the germination of the seed and during the early development of the plants, all the advantage was in favor of the heavier seeds.

The relative growth rates of the plants under observation were determined by means of three sets of measurements: (a) the length of the petioles, (b) the length and width of the terminal leaflets [the products of these two values giving rise to the so-called "leaf product" of McLean (1) who showed that the daily rate of increase, through growth, of the total leaf product is very nearly proportional to the corresponding rate of increase in actual leaf area which is more difficult to determine] and (c) the average dry weights of the plants harvested at regular intervals during the growth period. The growth rates of these plants were very slow during the first 4 weeks after planting, and during this time no measurements were made. The fifth week, however, marked a very rapid increase in the growth rates. Leaf measurements were begun when the plants were 4 weeks old and were repeated at 14-day intervals at the same time that several plants from each grade of seed were harvested and their dry weights obtained. The dates of harvesting and the average dry weights per plant corresponding to the different seed grades are given in table 2.

Table 2

Average Dry Weights of Crimson Clover Plants Grown from Seeds of Different Weights and Harvested at Various Intervals During the Growth Period

Dates of harvesting	Average dry weights per plant		
	2.0-mgm. seeds	3.5-mgm. seeds	5.0-mgm. seeds
	gm.	gm.	gm.
March 15	0.2112	0.2569	0.4063
March 29	1.0198	1.2822	1.9702
April 12	2.6673	4.6500	5.6494
April 26	5.9606	8.7917	7.2279

The data of table 2 show that the average dry weight of the plants from the heavier seeds is always superior to that of the plants from the seeds of lighter weight. This superiority of the plants from the heavier seeds was maintained throughout the growth period of 12 weeks. There is an exception, however, which should be noted. The average dry weight of the plants from the 5.0 mgm. seeds harvested April 26, was less than that of the plants from the seeds of medium weight. This may be accounted for by the fact that all the plants remaining at this time were quite large and those from the heavier seeds were somewhat crowded and unfavorably situated in the flats while the plants from the seeds of medium weight occupied much more favorable positions in the central portions of the flats and were somewhat less crowded.

The data of leaf measurements cannot here be presented but it may be stated that the leaf products of the plants from the seeds of different weights show the same relation to each other as do the average dry weights of the plants with respect to the rates of development. Because of the necessity of harvesting all of the remaining plants at the end of the twelfth week it is, of course, not now possible to state whether the superiority of the average dry weights of the plants from the heavier seeds over those from the lighter could be maintained throughout the later stages of growth to maturity. Experiments are now under way to determine this.

Reference

(1) McLean, F. T. 1917. A preliminary study of climatic conditions in Maryland, as related to plant growth. *In* Physiol. Res., v. 2, p. 129-208.

A STUDY OF THE RELATION OF VARIOUS FERTILIZER MIXTURES TO THE GROWTH OF CELERY IN MUCK SOILS

R. F. POOLE AND G. W. FANT

The muck soils in the bogs of Bergen County, New Jersey, are employed extensively in the growth of celery. Three crops of this staple vegetable are produced annually on the same soil areas of much of the cultivated bog region of this county. Rotation of crops is not commonly practiced but celery is grown year after year. The soil is thus rapidly depleted of the mineral elements required for plant growth and these elements are not returned to the soil annually in the proportions or forms for best growth, if at all. These muck soils contain from 60 to 85 per cent of organic matter which continues to decompose gradually under favorable conditions, but the application of a fertilizer mixture containing the mineral elements which would stimulate quick growth of celery would be of great value to the growers who till the muck soils.

This report describes briefly the results obtained with 21 different fertilizer mixtures comprising nitrate of soda, sulfate of ammonium, acid phosphate and muriate of potash, with "Golden Self-blanching" celery in muck soil in pot cultures. Unfortunately, an attack of bacterial heart rot during the later stages of growth caused considerable irregularity in the results. There are some significant points, however, that may prove of considerable value, especially since the work is now being continued with a green variety of celery which is more resistant to disease.

Two hundred pounds of muck soil upon which celery had been grown for several years, was collected from various points in a field. This soil was mixed thoroughly and passed through a sieve to remove all of the coarser particles. Five pounds of the soil was weighed into each of 24 1-gallon glazed pots after being air-dried. The water-holding capacity of the soil was found by a number of tests to be approximately 300 per cent, calculated on the dry-weight basis. Distilled water was added to produce a soil moisture content of approximately 50 per cent of the water-holding capacity of the soil.

Twenty-one different complete fertilizer mixtures were employed. The proportions of the mixtures to be used were calculated and weighed out in accordance with the well known triangle system as employed by Schreiner and Skinner[1]. The calculations were made on the basis that the active fertilizer elements P_2O_5, NH_3, and K_2O constituted a total of 16 per cent of each mixture. These were varied in the different mixtures by stages of 12.5 per cent of the total (increments of one-eighth), thus involving the 21 possible ratios or combinations of these three constituents, the percentages of which in the salts employed were determined by analysis. The mixtures were applied to the soil at the rate of 1,600 pounds per acre, the calculations being made on the basis of 2,000,000 pounds of soil to the acre. Ammonium sulfate and sodium nitrate were used as sources of nitrogen for the plants, each salt furnishing one-half the total nitrogen applied to each culture in the series. These two salts, therefore, are considered as a unit in supplying the fertilizer constituent NH_3. The other two fertilizer constituents (P_2O_5 and K_2O) were supplied as acid phosphate and muriate of potash. The fertilizer ingredients in the proper proportions were added to the air-dry soil, care being taken to get uniform distribution by thorough mixing.

The young plants were grown in a shallow flat until they were transplanted to the pots containing the treated soil. This was done when the plants were about 3 inches tall. The plants were selected to be as nearly alike as possible and three of these were transplanted to each pot. Distilled water was added to the cultures at frequent intervals and the pots were weighed once each week and made up to the required weight with the proper amounts of water. The soil of three cultures remained untreated as checks. The plants were transferred to the pots November 26, and were harvested March 13. The plants were dried to constant weight and the dry-weight yields obtained by the usual method.

From the beginning the plants in the cultures which had been treated with mixtures high in acid phosphate were stimulated in growth. The maximum yield was produced in the culture which had received the 2-10-4 mixture (2 per cent NH_3, 10 per cent P_2O_5, and 4 per cent K_2O). The yield from this culture was 46 per cent higher than the average yield from the check cultures. The next to the highest dry-weight yield was produced by the culture which had received the 4-6-6 mixture, this culture giving a yield which was 37 per cent higher than the average yield from the checks. The cultures which had received the 2-12-2 mixture and the 2-6-8 mixture each produced a yield which was approximately 20 per cent higher than the average yield from the checks. The yield from each of the other 17 cultures of the series fell considerably below this. The fertilizer mixtures which contained a relatively high percentage of the constituent NH_3 appeared always to depress the growth rates, some of these cultures producing yields which were considerably below the average yield from the check cultures. Mixtures which were relatively high in K_2O and correspondingly low in the other two constituents (P_2O_5 and NH_3) also gave poor yields.

All the experimental evidence obtained from this work suggests that the muck soil here dealt with can be greatly improved for the growth of celery by a moderate application of a fertilizer mixture low in the active constituent NH_3, relatively high in P_2O_5, and either relatively low or medium in its content of K_2O, such as the 2-10-4 or the 4-6-6 mixtures here employed.

Reference

(1) Schreiner, Oswald, and Skinner, J. J. 1918. The triangle system for fertilizer experiments. *In* Jour. Amer. Soc. Agron., v. 10, p. 225-246.

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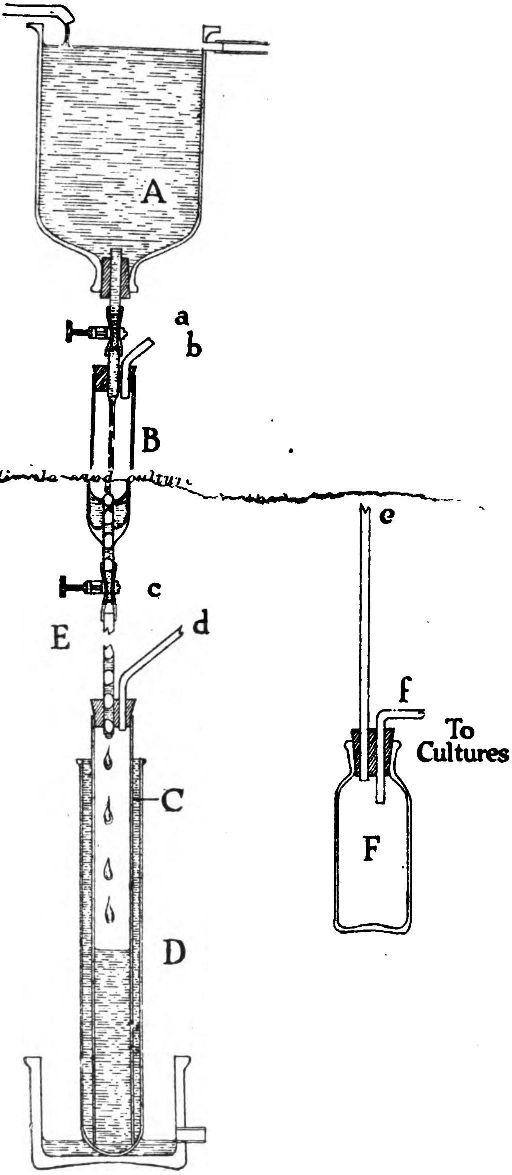

Fig. 2. Diagram of Apparatus Used in Aerating Culture Solutions of Series 3. *A*, Constant Level Reservoir; *a*, Rubber Tube Connection Regulating Water Flow; *B*, Suction Pump; *b*, Air Inlet; *C*, Air Reservoir; *c*, Rubber Tube Connection Regulating Flow of Air-Water Column; *D*, Overflow Tube for Outlet of Water and Excess Air; *d*, Air Outlet to Distributing Reservoir *F*; *f*, Air Tube to Cultures.

tap water followed with distilled water. For the drip sand cultures special containers were prepared by removing the bottoms from two clay pots, one of which was 6 inches in the upper diameter and 7 inches high, and the other 4½ inches in the upper diameter and 5 inches high. The two were then fitted together, the bottom of the larger into the top of the smaller, and cemented thus with shellac. The two were then mounted upon a third and smaller pot which formed the lower portion of the cone-shaped vessel having a perforation in the center of the bottom. This opening was fitted with a rubber stopper carrying a bent glass tube, the upper opening of which was plugged with glass wool. The tube served the purpose of carrying off the excess solution as it percolated through the sand from the constant drip.

The apparatus used for the forcing of air through the culture solutions of series 3 is a modification of the suction pump described by Neller (2). The essential features of this apparatus are diagramatically represented in figure 2. As here used the suction force of the pump was converted into a constant pressure force by conducting the water-air column into a tube *C* with large bore (3.8 cm. internal diameter) open at the lower end and placed in a second somewhat larger tube *D* which served as an outlet at the top for the water and excess air, so that the air inclosed in the inner tube *C* was always under constant pressure equivalent to that produced by the column of water displaced. From the top of the inner tube *C* an outlet tube *d* led to a distributing reservoir *F*. The flow of air from this reservoir to the cultures was regulated by means of pinchcocks.

Each drip solution culture was provided with an inlet tube passing to the bottom of the culture vessel while the overflow was provided for by an opening in the neck of the culture jar just beneath the paraffined cork stopper holding the plants. In both the drip solution cultures and in the drip sand cultures the inflowing solution coming from a constant level reservoir was passed through a small bulb-trap in which the rate of flow could be observed and regulated. Approximately 1 liter of solution per day was passed through each culture of series 3 and 4. With this rate of flow the hydrogen-ion concentration of the outflowing solution was maintained at pH values varying from 5.3 to 5.6.

The soybeans used were of the "Swan" variety. The seeds were germinated in sand on September 14 and transplanted to the various cultures on September 19. The plants were harvested on November 27, 1920, after a total growth period of 69 days.

In a study of the dry weight and nitrogen content, the plants of each culture were separated and the leaves, stems, fruit and roots (except in the cultures of series 3 and 4 where the roots were inseparable) were weighed separately. The root weights of all the series were obtained by weighing the roots with adhering sand particles, for more perfect aeration offered by the porous nature of the sand medium, aided by the constant drip which produced a continual movement of air as well as of solution through the sand cultures. The average total dry-weight yields of the different series are diagramatically represented in figure 3.

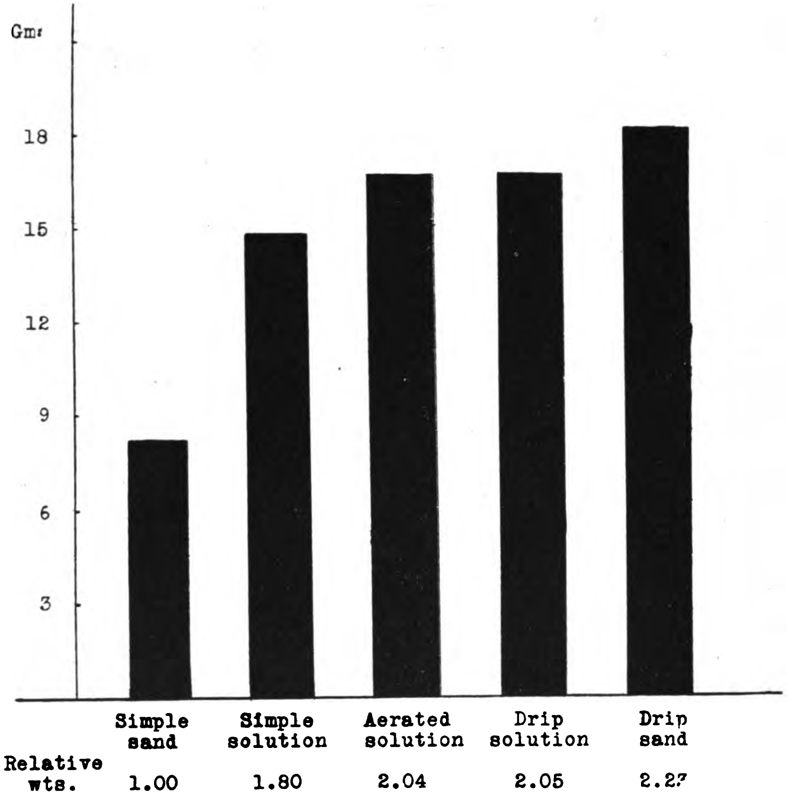

FIG. 3. DIAGRAM SHOWING THE ABSOLUTE AND RELATIVE DRY-WEIGHT YIELDS PER CULTURE IN EACH OF THE FIVE SERIES.

A summary of the nitrogen content of the various plant parts and of the entire plant expressed in percentage of the corresponding dry weights is given in table 2 for each series. The data of this table show no very definite correlations between the nitrogen content of the different plant parts and the different cultural treatments. In general, however, the percentage of nitrogen in the leaves, roots, tops as a whole, and the percentage of total nitrogen is always slightly lower for the plants of the simple solution and simple sand cultures than it is for the plants of the other series, but no such relation is shown for stems or fruit. In general, the highest percentage of nitrogen is shown for fruit and the lowest for stems and roots.

Table 2

Average Nitrogen Content of Plants and Plant Parts Expressed in Percentage of the Total Dry Weight

SERIES	Nitrogen in					
	Stems	Leaves	Fruit	Tops	Roots	Entire plant
	per cent	per cent	per cent	per cent	per cent	per cent
Simple solution	2.08	3.81	4.99	3.35	3.14	3.44
Simple sand	3.02	3.76	4.76	3.62	2.86	3.52
Aerated solution	3.19	4.01	4.80	3.79	3.18	3.75
Drip solution	2.51	4.30	4.71	3.68	4.29	3.88
Drip sand	3.26	3.95	4.72	3.92	3.80	3.82

Somewhat marked variations occur in the percentage of nitrogen of the stems and roots but these are inconsistent and no particular significance can be attached to them except in the case of the stems in which the nitrogen content appears to be directly related to fruit production, as is clearly brought out in the data of table 3. This table gives the average percentage of nitrogen in the various plant parts for those plants in each series producing the highest and the lowest yields of fruit. The data of table 3 show that a low nitrogen content of the stems is always correlated with hight fruit yields, and a high nitrogen content with low yields of fruit. No such relation is shown, however, for the other plant parts.

Table 3

Dry Weight of Fruit and Percentage of Nitrogen in Plant Parts for the Plants Producing the Highest and the Lowest Yields of Fruit in Each Series

	Series	Dry weight of fruit	Nitrogen in		
			Stems	Leaves	Roots
		gm.	per cent	per cent	per cent
Plant producing highest yield of fruit	Simple solution	1.7939	1.19	3.63	2.89
	Simple sand	0.4898	2.41	3.56	3.11
	Aerated solution	1.1928	2.30	4.55	3.64
	Drip solution	2.0839	1.27	3.76	4.22
	Drip sand	1.4424	2.45	3.59	3.78
Plant producing lowest yield of fruit	Simple solution	0.1627	2.70	3.84	3.48
	Simple sand	0.0563	3.26	3.82	2.70
	Aerated solution	0.2512	3.21	3.71	2.97
	Drip solution	0.0637	3.05	4.18	4.47
	Drip sand	0.3677	3.11	3.88	3.77

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THE INFLUENCE OF VOLUME UPON THE RATE OF CHANGE IN THE HYDROGEN--ION CONCENTRATION OF NUTRIENT SOLUTIONS IN CONTACT WITH PLANT ROOTS AND THE EFFECT OF THIS CHANGE UPON IRON AVAILABILITY

R. Marlin Barnette

The work here briefly reported was undertaken to study the relation of volume to the rates of change in the hydrogen-ion concentration of nutrient solutions in contact with the roots of wheat plants, and also to investigate the effect of this change upon the availability of iron supplied in the form of the so-called insoluble ferric phosphate. The work was carried out with spring wheat of the Marquis variety. The nutrient media used were Tottingham's (2) 4-salt solution No. $T_1R_1C_3$, and a modification of this solution by the substitution of ammonium sulfate for potassium nitrate in equivalent osmotic concentrations. These solutions were used in culture bottles of 250-cc., 500-cc., 1,000-cc., and 2,000-cc. capacities. Iron in the form of an aqueous suspension of ferric phosphate was added to the solutions at the rate of 5 mgm. of iron per liter of solution.

A single wheat plant was grown in each culture for a period of 36 days, and during this time the culture solutions were renewed at regular intervals of 3½ days. Each 3½-day period between two successive solution changes will be designated a growth interval. At the end of the various growth intervals, after the solutions had been renewed, the old solutions were made up to their original volumes with distilled water and their pH values determined by the colorimetric method, using the double-tube standards of Gillespie (1) and the apparatus devised by Van Alstine (3). The cultures were conducted in duplicate from March 4 to April 9. The plants were harvested and the dry weights obtained in the usual way.

Table 1 presents the average absolute dry-weight yield values (total for tops and roots) of the plants and the average pH values of the culture solutions corresponding to the different volumes for five selected growth intervals. While the data are of a preliminary nature, still some very interesting and important points are brought out.

Considering first the different volumes of the Tottingham solution ($T_1R_1C_3$), it will be observed from an inspection of table 1 that the hydrogen-ion concentration decreased very rapidly in the 250-cc. cultures, while the decrease was, of course, progressively less rapid in solutions of the 500-cc., 1,000-cc., and the 2,000-cc. cultures. Chlorosis appeared in the plants of the 250-cc. cultures about the twentieth day, or during the sixth growth interval. In the plants of the 500-cc. cultures chlorosis appeared about the twenty-third day or between the sixth and eighth growth intervals. The plants in the 1,000-cc. cultures gave no indication of yellowness of the leaves before about the twenty-sixth day, or during the eighth growth interval, while in the plants of the 2,000-cc. cultures there was only a very slight indication of a chlorotic condition at the end of the growth period which was terminated at the end of the tenth interval.

Table 1

Average Total Dry Weights of Plants and pH Values of the Nutrient Solutions

	Volume of solution	Total dry weight of plants	pH *values of solutions at end of selected growth intervals				
			2d interval	4th interval	6th interval	8th interval	10th interval
	cc.	gm.					
Tottingham's solution $T_1R_1C_3$	250	1.5353	5.55	6.25	7.00	7.10	7.25
	500	2.1181	5.15	5.67	6.35	6.95	7.20
	1000	2.6808	4.95	5.35	6.00	6.55	6.70
	2000	3.5358	4.70	5.20	5.70	6.20	6.35
Ammonium sulfate modification of Tottingham's solution $T_1R_1C_3$	250	2.8654	4.60	4.28	4.95	6.50	7.10
	500	3.1287	4.60	4.40	4.45	5.13	7.15
	1000	3.5605	4.60	4.45	4.50	4.50	6.13
	2000	4.0330	4.60	4.60	4.50	4.45	5.00

*The initial pH values of the solutions were approximately 4.7.

The hydrogen-ion concentration of the solutions containing ammonium sulfate (Tottingham solution $T_1R_1C_3$ modified) was increased, as the result of contact with the plant roots, during the growth intervals covering a period of 3 weeks in the 250-cc. cultures, and then rather suddenly the direction of the change in reaction was reversed. This reversal of the direction in the change of the hydrogen-ion concentration was progressively delayed with the larger volumes of nutrient solution. Thus in the 2,000-cc. cultures the reversal in the direction of this change was not observed until the end of the last growth interval and the decrease in the hydrogen-ion concentration of the solution during this interval was only very slight, the pH values of the solution at the beginning and at the end of the interval being 4.7 and 5.0, respectively. The exact cause of the sudden reverse from an increase to a marked decrease in the hydrogen-ion concentration of the modified Tottingham solution ($T_1R_1C_3$) in contact with the plant roots is not at all clear at the present time.

The plants grown in 250 cc. of the solution containing ammonium sulfate developed chlorosis about the thirtieth day, or during the ninth interval, while in the plants of the 500-cc. cultures a slight chlorotic condition appeared during the last interval. Chlorosis did not appear at all in the plants of the 1,000-cc. nor in those of the 2,000-cc. cultures.

As in the plants grown in the unmodified Tottingham solution, so also in the modified solution a sudden and marked decrease in the hydrogen-ion concentration was soon thereater followed by the appearance of a chlorotic condition in the plants. With both types of solutions in contact with the plant roots the change from a higher to a lower hydrogen-ion concentration was more rapid and more marked in the smaller volumes, as was to be expected, but this always resulted in a correspondingly earlier development of chlorosis in the plants. It thus appears that the ability of these plants to obtain sufficient iron from the nutrient solution for normal development is determined in large measure by the hydrogen-ion concentration of the solution. The higher availability of iron to the plants in the solution containing ammonium sulfate is undoubtedly due to the fact that in this solution the hydrogen-ion concentration is maintained at a higher level as the result of contact with the plant roots thus giving a higher degree of solubility to the ferric phosphate employed as a source of iron for the plants.

The dry-weight data of table 1 show that the average total yield values are progressively higher as the volumes of the solutions increase. This is true with respect to the yields produced by both types of nutrient solutions employed. The plants may have been somewhat limited in their growth by the smaller volumes of the solutions, but it is not probable that the retarding influence of the smaller volumes was very great since the solutions were renewed regularly every 3½ days and each culture comprised only a single plant. The progressive increase in yields with increase in the volumes of the solutions is, however, directly correlated with a corresponding delay and a correspondingly lower degree of intensity in the development of the chlorotic condition of the plants resulting from a lack of available iron.

It will be observed that the average yields from the unmodified Tottingham solution are always considerably lower than are the average yields from the corresponding volumes of the solution containing ammonium sulfate. This is probably due not to a lower efficiency of the main salt constituents in the former solution but to the higher availability of iron in the latter which prevented the development of chlorosis in the plants grown in the larger volumes of solution and delayed its appearance in the plants grown in the smaller volumes.

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(4) Haenseler, C. M. 1921. The effect of salt proportions and concentration on the growth of Aspergillus niger. *In* Amer. Jour. Bot., v. 8, no. 3, p. 147-163.

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REPORT OF THE DEPARTMENT OF ENTOMOLOGY

Department of Entomology

THOMAS J. HEADLEE, PH.D., *Entomologist.*
CHARLES S. BECKWITH, B.SC., *Assistant Entomologist.*
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W. H. DUMONT, *Research Fellow.*
‡KARL ILG, *Laboratory Assistant.*
AUGUSTA E. MESKE, *Stenographer and Clerk.*

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*Resigned July 15, 1920.
†Appointed July 15, 1920.
‡Appointed April 16, 1921.

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Report of the Department of Entomology

THOMAS J. HEADLEE

INTRODUCTION

As in previous years the attention of the entomologist and his staff has been given too:

(1) The furnishing of information concerning the nature and control of injurious and beneficial insects in response to direct requests of the citizens of the state;
(2) The preparation of bulletins and circulars setting forth the results of investigation of insects injurious and beneficial to the agricultural, industrial and urban life of the state;
(3) The investigation of the insects injurious to agricultural, industrial and urban life;
(4) The prosecution of studies relative to the growing of cranberries;
(5) The study of certain phases of the biology of sewage disposal;
(6) The control of the mosquito.

Miss Augusta Meske, assisted by Miss Margaret V. Fross and other temporary employees, has conducted the clerical work of the office. Dr. Alvah Peterson has devoted his attention to the investigation of paradichlorobenzene as a means of controlling the peach borer. Dr. Mitchell Carroll resigned as assistant entomologist in the mosquito-control work on July 15, 1920, and his place has been taken by Wilbur M. Walden, who previously had been, for a number of years, connected with the Mosquito Commission in the County of Essex. Charles S. Beckwith has devoted practically all of his time to the study of the problems of cranberry culture. W. H. Dumont, as fellow in the department, has devoted his attention to certain phases of the biology of sewage disposal. On April 16, Karl Ilg was employed on a part-time basis as laboratory assistant in the preparation and care of collections and general laboratory service.

CORRESPONDENCE

The correspondence of this year has required the preparation of about 6,000 letters. Inquiries concerning 172 different species of insects summarized in the following list have been received and attended to.

Arachnida

Latin Name	*Common Name*	*Locality*	*Date*
Arachnidæ	Spider	South Orange	June 30,
Bryobia pratenses Garman	Clover mite	Haddonfield	Aug. 7, '20
Bryobia pratenses Garman	Clover mite	Spring Lake	Nov. 30,
Eriophyes acericola Garman	Fusiform maple gall	Morganville	May 3, '21
Eriophyes acericola Garman	Fusiform maple gall	Summit	June 14,
Eriophyes acericola Garman	Fusiform maple gall	Summit	June 22,
Eriophyes pyri Pgst.	Pear leaf blister mite	New Brunswick	Aug. 11, '20
Eriophyes pyri Pgst.	Pear leaf blister mite	Cedar Grove	April 30, '21
Eriophyes pyri Pgst.	Pear leaf blister mite	Dover	June 15,
Eriophyes pyri Pgst.	Pear leaf blister mite	Sea Girt	June 17,
Eriophyes sp.	Mite	Scotch Plains	April 18, '21
Eriophyes sp.	Mite	Bridgeton	April 23,
Tetranychus bimaculatus Harv.	Red Spider	Seabright	April 7,
Tetranychus bimaculatus Harv.	Red Spider	Plainfield	June 3,
Tetranychus bimaculatus Harv.	Red Spider	Westfield	June 4,
Tetranychus bimaculatus Harv.	Red Spider	Martinsville	June 9,
Tetranychus sp.	Red Spider	East Orange	Aug. 25, '20
Tetranychus sp.	Red Spider	Plainfield	Sept. 2, '20
Tetranychus sp.	Red Spider	New York City	Sept. 29,
Tetranychus sp.	Red Spider	Gladstone	Jan. 5, '21
Tetranychus sp.	Red Spider	P rth Amboy	June 9,
Tetranychus sp.	Red Spider	Brentwood	June 9,
Tetranychus sp.	Red Spider	Essex Fells	June 11,
Tyroglyphus farinæ	Flour mite	Moorestown	Sept. 16, '20
Trombidium sp.	Common chigger	Somerville	April 4,

Insecta

Thysanura

Thermobia domestica Pack.	Fish moth	Dover	Feb. 22,
Thysanura sp.	Bristle tails	Juliustown	Sept. 21, '20

Corrodentia

Troctes divinatorius Mull	Book louse	Woodbury	June 21, '21

Platyptera

Chauliodes pectinicornis Linn.	Hellgramites	Englishtown	June 9,

Trichoptera

Corydalis cornuta Linn.	Caddice flies	Hohokus	April 19,

Homoptera

Aphididæ	Plant lice	W. Long Branch	July 14, '20
Aphididæ	Plant lice	Woodstown	July 21,

Homoptera—Continued

Latin Name	*Common Name*	*Locality*	*Date*
Aphididæ	Plant lice	Merchantville	Aug. 3,
Aphididæ	Plant lice	Irvington	Sept. 1,
Aphididæ	Plant lice	Toms River	Oct. 5,
Aphididæ	Plant lice	New York City	April 21, '21
Aphididæ	Plant lice	Summit	June 2,
Aphididæ	Plant lice	Haddonfield	June 3,
Aphididæ	Plant lice	Elizabeth	June 6,
Aphididæ	Plant lice	Hammonton	June 14,
Aphididæ	Plant lice	Newark	June 17,
Aphididæ	Plant lice	Summit	June 22,
Aphididæ	Plant lice	Washington	June 23,
Aphididæ	Plant lice	Englewood	June 28,
Aphis brassicæ Linn.	Cabbage plant lice	New Brunswick	June 25,
Aphis maidiradicis Forbes	Corn-root louse	Paterson	Aug. 5, '20
Aphis maidiradicis Forbes	Corn-root louse	Camden	Aug. 6,
Aphis middletoni	The Eregeron root-aphis	Westfield	May 23, '21
Aphis pomi DeG.	Green apple aphis	Palmyra	July 4, '20
Aphis pomi DeG.	Green apple aphis	New Brunswick	July 21,
Aphis pomi DeG.	Green apple aphis	Elizabeth	May 24, '21
Aphis pomi DeG.	Green apple aphis	Summit	June 8,
Aphis pomi DeG.	Green apple aphis	Westfield	June 22,
Aphis pomi DeG.	Green apple aphis	South Orange	June 28,
Aphis pomi DeG.	Green apple aphis	Hilton	June 28,
Aphis prunifoliæ Fitch	Plum aphis	Dover	May 26,
Aphis prunifoliæ Fitch	Plum aphis	Hammonton	June 8,
Aphis prunifoliæ Fitch	Plum aphis	Orange	June 10,
Aspidiotus perniciosus Comst.	San Jose Scale	Glen Ridge	Mar. 21,
Ceresa bubalus Fabr.	Buffalo tree hopper	Ridgewood	Nov. 24, '20
Ceresa bubalus Fabr.	Buffalo tree hopper	Mt. Holly	April 9, '21
Ceresa bubalus Fabr.	Buffalo tree hopper	Freehold	April 12,
Ceresa bubalus Fabr.	Buffalo tree hopper	Ridgewood	June 7,
Chaitophorus aceris Linn.	Norway maple aphis	Washington	June 11,
Chermaphis abieticolens Thos.	Spruce Gall aphid	Hoboken	May 5,
Chermaphis abieticolens Thos.	Spruce Gall aphid	Morristown	June 2,
Chermaphis pinicortis Fitch	Pine bark aphid	Paterson	Mar. 28,
Chermaphis pinicortis Fitch	Pine bark aphid	Caldwell	April 9,
Chermaphis pinicortis Fitch	Pine bark aphid	Lakewood	May 2,
Chermaphis pinicortis Fitch	Pine bark aphid	Locust	June 11,
Chermaphis pinicortis Fitch	Pine bark aphid	Lakewood	June 27,
Chionaspis furfurus Fitch	Scurfy scale	Lincroft	Jan. 21,
Chionaspis pinifoliæ Fitch	Pine leaf scale	Passaic	July 13, '20
Chionaspis pinifoliæ Fitch	Pine leaf scale	Little Silver	Sept. 18,
Chionaspis pinifoliæ Fitch	Pine leaf scale	New York City	Sept. 29,

Homoptera—Continued

Latin Name	*Common Name*	*Locality*	*Date*
Chionaspis pinifoliæ Fitch	Pine leaf scale	Moorestown	Oct. 13, '20
Chionaspis pinifoliæ Fitch	Pine leaf scale	Little Silver	Nov. 26,
Chionaspis pinifoliæ Fitch	Pine leaf scale	Morristown	June 2, '21
Chionaspis pinifoliæ Fitch	Pine leaf scale	Plainfield	June 3,
Colopha ulmicola Fitch	Cockscomb gall	Leonardo	Oct. 20, '20
Colopha ulmicola Fitch	Cockscomb gall	Bridgeton	June 16, '21
Eulecanium nigrofasciatum Perg.	Terrapin scale	Salem	Nov. 11, '20
Eulecanium nigrofasciatum Perg.	Terrapin scale	Haddonfield	Feb. 22, '21
Eulecanium nigrofasciatum Perg.	Terrapin scale	Paterson	April 22,
Eulecanium nigrofasciatum Perg.	Terrapin scale	Trenton	May 12,
Eulecanium nigrofasciatum Perg.	Terrapin scale	Paterson	May 13,
Eulecanium nigrofasciatum Perg.	Terrapin scale	Bloomfield	May 19,
Eulecanium nigrofasciatum Perg.	Terrapin scale	Nutley	June 8,
Eulecanium nigrofasciatum Perg.	Terrapin scale	Summit	June 14,
Eulecanium nigrofasciatum Perg.	Terrapin scale	Summit	June 22,
Eulecanium tulipiferæ Cook	Tulip soft scale	Bridgeton	June 13,
Eulecanium tulipiferæ Cook	Tulip soft scale	Westfield	June 17,
Jassidæ sp.	Leaf hoppers	Dutch Neck	Feb. 25,
Jassidæ sp.	Leaf hoppers	Plainfield	May 28,
Lonistigma caryæ Linn.	Hickory aphis	Berlin	April 18, '21
Lonistigma caryæ Linn.	Hickory aphis	Camden	May 19,
Lonistigma caryæ Linn.	Hickory aphis	Butler	June 14,
Lepidosaphes ulmi Linn.	Oyster shell scale	Seaside Park	June 18,
Lepidosaphes ulmi Linn.	Oyster shell scale	Princeton	Aug. 27, '20
Lepidosaphes ulmi Linn.	Oyster shell scale	East Orange	Sept. 16,
Lepidosaphes ulmi Linn.	Oyster shell scale	New York City	Oct. 5,
Longistigma caryæ Harr.	Hickory aphis	Toms River	May 23,
Macrosiphum pisi Kalt	Pea aphis	Camden	May 27,
Macrosiphum rosæ Linn.	Rose aphis	New York City	June 21,
Myzus cerasi Fab.	Black cherry aphis	Dunellen	June 2,
Myzus cerasi Fab.	Black cherry aphis	Plainfield	June 7,
Myzus cerasi Fab.	Black cherry aphis	Elizabeth	June 15,
Myzus cerasi Fab.	Black cherry aphis	Dover	June 15,
Myzus persicæ Sulz.	Green peach aphis	Elizabeth	May 2,
Myzus persicæ Sulz.	Green peach aphis	Woodbury	June 21,
Myzus ribis Linn.	Currant aphis	Dover	May 26,
Myzus ribis Linn.	Currant aphis	Belleville	May 31,
Myzus ribis Linn.	Currant aphis	Orange	June 10,
Myzus ribis Linn.	Currant aphis	Mendham	June 29,
Nectarophora viticola Thos.	Grape aphis	New Brunswick	June 2,
Nectarophora viticola Thos.	Grape aphis	Perth Amboy	June 9,
Nectarophora viticola Thos.	Grape aphis	Sewaren	June 9,
Nectarophora viticola Thos.	Grape aphis	South Orange	June 17,

Homoptera—Continued

Latin Name	*Common Name*	*Locality*	*Date*
Pemphigus acerifolii Riley	Woolly maple leaf aphid	South Orange	May 17,
Pemphigus acerifolii Riley	Woolly maple leaf aphid	Paterson	June 30,
Phenacoccus acericola King	False maple scale	Morris Plains	June 20,
Phenacoccus acericola King	False maple scale	Englishtown	June 24,
Phenacoccus acericola King	False maple scale	Oldwick	June 30,
Phyllaphis fagi Linn.	Woolly beech aphis	West Orange	June 15,
Phylloxera caryea-venæ Fitch	Hickory vein gall louse	Camden	May 13,
Phylloxera foveola Shin.	Hickory button gall	Crosswick	June 11,
Phylloxera vastatrix Planch.	Grape phylloxera	Plainfield	May 31,
Prociphilus imbricator Fitch	Woolly beech aphis	Plainfield	May 28,
Pseudococcus comstocki Kuwana	Japanese mealy bug	Asbury Park	Oct. 14, '20
Psylla pyricola Forst.	Pear psylla	Gasport, N. Y.	Oct. 19,
Pulvinaria innumerabilis Rath.	Cottony maple scale	Metuchen	June 7,
Pulvinaria innumerabilis Rath.	Cottony maple scale	Roselle	June 9,
Pulvinaria innumerabilis Rath.	Cottony maple scale	Westfield	June 11,
Pulvinaria innumerabilis Rath.	Cottony maple scale	Elizabeth	June 17,
Pulvinaria innumerabilis Rath.	Cottony maple scale	Somerville	June 17,
Pulvinaria innumerabilis Rath.	Cottony maple scale	Roselle Park	June 18,
Pulvinaria innumerabilis Rath.	Cottony maple scale	East Orange	June 21,
Pulvinaria innumerabilis Rath.	Cottony maple scale	Westfield	June 22,
Pulvinaria innumerabilis Rath.	Cottony maple scale	Roselle	June 23,
Pulvinaria innumerabilis Rath.	Cottony maple scale	Cranford	June 25,
Schizoneura lanigera Hausm.	Woolly apple aphis	Pensauken	July 8, '20
Schizoneura lanigera Hausm.	Woolly apple aphis	Bound Brook	May 9, '21
Schizoneura lanigera Hausm.	Woolly apple aphis	Irvington	May 30,
Schizoneura lanigera Hausm.	Woolly apple aphis	Maplewood	June 17,
Schizoneura lanigera Hausm.	Woolly apple aphis	Gladstone	June 28,
Schizoneura lanigera Hausm.	Woolly apple aphis	South Amboy	June 28,
Schizoneura lanigera Hausm.	Woolly apple aphis	South Orange	June 28,
Trioza tripunctata Fitch	Bramble flea louse	Freehold	Nov. 5, '20
Trioza tripunctata Fitch	Bramble flea louse	Mays Landing	May 23, '21
Trioza tripunctata Fitch	Bramble flea louse	Bridgeton	June 8.
Typhlocyba tricincta Fitch	Grape vine leaf hopper	Dutch Neck	Feb. 25,

Hemiptera

Latin Name	*Common Name*	*Locality*	*Date*
Aleyrodes vaporariorum Westw.	Greenhouse white fly	Verona	Sept. 16, '20
Anasa tristis DeG.	Squash bug	Elizabeth	Feb. 21, '21
Anasa tristis DeG.	Squash bug	Roselle	June 25.
Arilus cristatus Linn.	Wheel bug	Sewell	Sept. 2, '20
Arilus cristatus Linn.	Wheel bug	Woodbury	June 8, '21
Cimex lectularius Linn.	Bed bug	Ocean Grove	June 7.
Heterocordylus malinus Reuter	Apple red bug	Ramsay	Oct. 5, '20
Heterocordylus malinus Reuter	Apple red bug	Haddonfield	April 4, '21

Hemiptera—Continued

Latin Name	*Common Name*	*Locality*	*Date*
Lygus sp.	Leaf bug	Plainfield	June 7,
Stephanitis rhododendri Horv.	Rhododendron lace bug	Millburn	Mar. 31,
Orthoptera			
Microcentrum rhombifolium Sauss.	Katydid	Toms River	Sept. 24, '20
Microcentrum rhombifolium Sauss.	Katydid	Somerville	Nov. 30,
Microcentrum rhombifolium Sauss.	Katydid	Vineland	Feb. 22. '21
Microcentrum rhombifolium Sauss.	Katydid	Hammonton	Feb. 22,
Microcentrum rhombifolium Sauss.	Katydid	New Brunswick	April 7,
Oecanthus nigricornis Wlk.	Striped tree cricket	Malaga	Feb. 15,
Oecanthus nigricornis Wlk.	Striped tree cricket	Mt. Holly	April 9,
Oecanthus niveus DeG.	Snowy tree cricket	Malaga	Feb. 15,
Paratenodera sinensis Sauss.	Chinese Mantid	Jobstown	Oct. 15, '20
Paratenodera sinensis Sauss.	Chinese Mantid	New York City	Feb. 10, '21
Paratenodera sinensis Sauss.	Chinese Mantid	Haddonfield	Feb. 21,
Paratenodera sinensis Sauss.	Chinese Mantid	Delair	Feb. 27,
Paratenodera sinensis Sauss.	Chinese Mantid	Mt. Holly	April 12,
Coleoptera			
Adalia bipunctata Linn.	Two-spotted lady bird	Westfield	June 22,
Agonoderus pallipes Fab.	Ground beetle	New Egypt	June 30,
Alaus oculatus Linn.	The eyed elater	Haddonfield	June 28,
Amphicerus bicaudatus Say	Grape cane borer	Keyport	July 15, '20
Amphicerus bicaudatus Say	Grape cane borer	Dover	May, 26.
Anomala lucicola Fab.	Vine chafer	Marlton	July 1, '20
Anthonomus signatus Say	Strawberry weevil	Dover, Del.	Dec. 8,
Balaninus proboscideus Fab.	Large chestnut weevil	Minotola	June 7, '21
Balaninus rectus Say	Chestnut weevil	Minotola	June 7,
Bruchus obtectus Say	Bean weevil	Dunellen	Aug. 26. '20
Bruchus obtectus Say	Bean weevil	Rahway	Nov. 11.
Bruchus obtectus Say	Bean weevil	Brooklyn	Dec. 11,
Bruchus obtectus Say	Bean weevil	Sewell	Mar. 31, '21
Carabidæ	Ground beetles	Bridgeton	July 30, '20
Carabidæ	Ground beetles	Haddonfield	April 4. '21
Chelymorpha argus Licht.	Argus tortoise-beetle	Salem	July 30. '20
Chilocorus bivulnerus Muls.	Twice-stabbed lady-bird	Perth Amboy	June 9.
Coccinella sp.	Lady bird beetle	Palmyra	July 4, '20
Coccinella sp.	Lady bird beetle	Dover	May 26, '21
Cocinella 9-notata Hbst.	Nine-spotted lady-bird	Gladstone	June 28,
Conotrachelus nenuphar Hbst.	Plum curculio	Toms River	Sept. 29, '20
Conotrachelus nenuphar Hbst.	Plum curculio	Ramsay	Oct. 5,
Conotrachelus nenuphar Hbst.	Plum curculio	West Creek	Nov. 3,
Conotrachelus nenuphar Hbst.	Plum curculio	Atlantic Highlands	Nov. 12,

Coleoptera—Continued

Latin Name	*Common Name*	*Locality*	*Date*
Conotrachelus nenuphar Hbst.	Plum curculio	Haddon Heights	Jan. 26, '21
Conotrachelus nenuphar Hbst.	Plum curculio	Bloomfield	Feb. 10,
Conotrachelus nenuphar Hbst.	Plum curculio	Elizabeth	Mar. 16,
Conotrachelus nenuphar Hbst.	Plum curculio	Allentown	May 24,
Conotrachelus nenuphar Hbst.	Plum curculio	Dover	May 26,
Conotrachelus nenuphar Hbst.	Plum curculio	Plainfield	May 31,
Conotrachelus nenuphar Hbst.	Plum curculio	Roselle Park	June 6,
Conotrachelus nenuphar Hbst.	Plum curculio	Brookside	June 9,
Conotrachelus nenuphar Hbst.	Plum curculio	Orange	June 10,
Conotrachelus nenuphar Hbst.	Plum curculio	Westville	June 11,
Conotrachelus nenuphar Hbst.	Plum curculio	Lake Hopatcong	June 14,
Conotrachelus nenuphar Hbst.	Plum curculio	Orange	June 18,
Conotrachelus nenuphar Hbst.	Plum curculio	Elizabeth	June 22,
Conotrachelus nenuphar Hbst.	Plum curculio	Brentwood	June 30,
Crioceris asparagi Linn.	Asparagus beetle	Elizabeth	April 19,
Crioceris asparagi Linn.	Asparagus beetle	South Orange	May 18,
Crioceris asparagi Linn.	Asparagus beetle	Hopewell	May 23,
Crioceris asparagi Linn.	Asparagus beetle	Leesburg	May 23,
Crioceris asparagi Linn.	Asparagus beetle	Amboy, Ill.	June 7,
Diabrotica vittata Fab.	Striped cucumber beetle	Elizabeth	Feb. 21,
Elateridæ sp.	Wire worms	Haddonfield	April 22,
Elateridæ sp.	Wire worms	Marlton	April 23,
Elateridæ sp.	Wire worms	Westfield	June 30,
Melanotus sp.	Wire worms	Bronston	May 24,
Melanotus sp.	Wire worms	Mt. Holly	June 18,
Epicauta marginata Fab.	Margined blister beetle	New York City	July 29, '20
Epicauta marginata Fab.	Margined blister beetle	Millington	Aug. 11,
Epicauta pennsylvanica DeG.	Black blister beetle	Woodbury	Aug. 4,
Epicauta pennsylvanica DeG.	Black blister beetle	Cookstown	Aug. 5,
Epitrix cucumeris Harr.	Potato flea beetle	Tenafly	May 28, '21
Euphoria inda Linn.	Brown fruit chafer	Peapack	April 15,
Gnathocerus cornutus Fab.	Broad-horned flour beetle	Somerville	May 21,
Haltica chalybea Ill.	Grape flea beetle	Westfield	June 30,
Lachnosterna sp.	White Grub	Idaville, Pa.	July 28, '20
Lachnosterna sp.	White Grub	New Brunswick	Aug. 2,
Lachnosterna sp.	White Grub	Ridgewood	Aug. 27,
Longitarsus melanurus Mels.	Flea beetle	Bloomfield	Nov. 11, '20
Macrodactylus subspinosus Fab.	Rose bug	Marlton	July 1,
Macrodactylus subspinosus Fab.	Rose bug	New Brunswick	June 2, '21
Macrodactylus subspinosus Fab.	Rose bug	Bergenfield	June 6,
Macrodactylus subspinosus Fab.	Rose bug	Monmouth Jct.	June 6,
Macrodactylus subspinosus Fab.	Rose bug	Minotola	June 7,
Macrodactylus subspinosus Fab.	Rose bug	Summit	June 7,
Macrodactylus subspinosus Fab.	Rose bug	Willow Grove, Pa.	June 9,

Coleoptera—Continued

Latin Name	*Common Name*	*Locality*	*Date*
Macrodactylus subspinosus Fab.	Rose bug	Paterson	June 11,
Macrodactylus subspinosus Fab.	Rose bug	Newark	June 14,
Macrodactylus subspinosus Fab.	Rose bug	New York City	June 15,
Macrodactylus subspinosus Fab.	Rose bug	Pompton Plains	June 15,
Macrodactylus subspinosus Fab.	Rose bug	Westwood	June 15,
Macrodactylus subspinosus Fab.	Rose bug	Amherst, Mass.	June 17,
Macrodactylus subspinosus Fab.	Rose bug	West Philadelphia, Pa.	June 17,
Macrodactylus subspinosus Fab.	Rose bug	Ringoes	June 18,
Macrodactylus subspinosus Fab.	Rose bug	Rutherford	June 21,
Macrodactylus subspinosus Fab.	Rose bug	Bogota	June 23,
Macrodactylus subspinosus Fab.	Rose bug	Ridgewood	June 30,
Popilia japonica Newn.	Japanese beetle	Haddonfield	April 7,
Pelidnota punctata Linn.	Spotted Pelidnota	Roseland	July 28, '20
Phyllotreta vittata Fab.	Striped cabbage flea beetle	Haddonfield	July 9,
Phytonomus punctatus Fab.	Clover leaf weevil	Somerville	April 26, '21
Plagionotus speciosus Say	Oak borer	Paterson	June 30, '21
Prionomerus calceatus Say	Leaf miner in sassafras	Paterson	Sept. 25, '20
Pitnus fur Linn.	White marked spider beetle	Bloomfield	Nov. 15,
Saperda candida Fab.	Round headed apple borer	Palmyra	July 4,
Saperda candida Fab.	Round headed apple borer	Maplewood	Oct. 29,
Saperda candida Fab.	Round headed apple borer	Lahaska, Pa.	Feb. 28, '21
Saperda candida Fab.	Round headed apple borer	Haddonfield	April 7,
Silvanus surinamensis Linn.	Saw-toothed grain beetle	Somerville	May 21,
Silvanus surinamensis Linn.	Saw-toothed grain beetle	Paterson	June 15,
Strigoderma arboricola Fab.	Lamellicorn beetle	Cape May Court House	July 14, '20
Strigoderma arboricola Fab.	Lamellicorn beetle	Cape May	July 15,
Strigoderma arboricola Fab.	Lamellicorn beetle	Haddonfield	July 15,
Tribolium confusum Duv.	Confused flour beetle	Somerville	May 21,
Typophorus canellus Fab.	Strawberry root worm	Union	Oct. 3, '20

Lepidoptera

Latin Name	*Common Name*	*Locality*	*Date*
Alypia octomaculata Fab.	Eight spotted forester	Roseland	July 28, '20
Ancylis comptana Froehl.	Strawberry leaf roller	Elm	July 30,
Ancylis comptana Froehl.	Strawberry leaf roller	West Springfield, Mass.	Sept. 27,
Anisota senatoria S. & A.	Spiny oak caterpillar	Lakewood	Sept. 25,
Anisota senatoria S. & A.	Spiny oak caterpillar	Morganville	Sept. 25,
Anisota senatoria S. & A.	Spiny oak caterpillar	Freehold	Sept. 27,
Cacoecia cerasivorana Fitch	Cherry tree ugly nest builder	Morristown	June 13, '21
Carpocapsa pomonella Linn.	Codling moth	Riverton	Aug. 30, '20
Carpocapsa pomonella Linn.	Codling moth	Atlantic Highlands	Nov. 12,
Carpocapsa pomonella Linn.	Codling moth	Wyoming, Del.	June 28, '21
Crambus calliginosellus Clem.	Corn root web worm	Mt. Holly	June 28,
Datana integerrima G. & R.	Black walnut caterpillar	Hammonton	Aug. 3, '20

Lepidoptera—Continued

Latin Name	*Common Name*	*Locality*	*Date*
Datana integerrima G. & R.	Black walnut caterpillar	Sewell	Sept. 15,
Datana ministra Dru.	Yellow-necked caterpillar	Metuchen	Sept. 7,
Datana ministra Dru.	Yellow-necked caterpillar	Raritan	Sept. 25,
Desmia funeralis Hubn.	Grape leaf folder	New York City	May 24, '21
Desmia funeralis Hubn.	Grape leaf folder	Dover	May 26,
Drosophila ampelophila Loew.	Pomace fly	Juliustown	Sept. 21, '20
Ephestia kuehniella Zell.	Mediterranean flour moth	Dover	Mar. 18, '21
Eulia pinatubana Kearf.	Pine tube moth	Camden	Oct. 27, '20
Heliothis obsoleta Fab.	Corn ear worm	Boston, Mass.	Sept. 29,
Heliothis obsoleta Fab.	Corn ear worm	Haddonfield	Sept. 27,
Hemileuca maia Dru.	Oak buck moth	Wharton	Mar. 18, '21
Hyphantria cunea Dru.	Fall web worm	Bayonne	Sept. 21, '20
Isia isabella S. & A.	Woolly bears	Cedarville	Nov. 16,
Isia isabella S. & A.	Woolly bears	Caldwell	Nov. 30,
Isia isabella S. & A.	Woolly bears	Hopewell	May 6, '21
Laspyresia molesta Busck.	Oriental peach moth	Little Silver	July 24, '20
Laspyresia molesta Busck.	Oriental peach moth	Bridgeton	Oct. 16,
Malacosoma americana Fabr.	Apple tree tent caterpillar	Bordentown	Jan. 26, '21
Melittia satyriniformis Hbn.	Squash vine borer	Plainfield	Aug. 27, '20
Nadata gibbosa S. & A.	Green oak caterpillar	Bridgeton	June 30, '21
Nepticula sp.	Leaf miner	Spring Lake	May 18,
Noctuidæ sp.	Cut-worm	Clifton	Aug. 5, '20
Noctuidæ sp.	Cut-worm	Arlington	Dec. 9,
Oxyptilus periscelidactylus Fitch	Grape plume moth	Elizabeth	May 24, '21
Papaipema nitela Gn.	Common stalk borer	Paterson	July 5, '20
Papaipema nitela Gn.	Common stalk borer	Plainfield	July 14,
Papaipema nitela Gn.	Common stalk borer	Asbury	June 18, '21
Papaipema nitela Gn.	Common stalk borer	Bridgeton	June 30,
Papilio polyxenus Fab.	Celery caterpillar	Englewood	Oct. 23, '20
Phlegethontius celeus	Tomato horn worm	Paterson	April 8, '21
Pieris rapæ Linn.	Imported cabbage worm	New Brunswick	June 25,
Polychrosis viteana Clem.	Grape berry moth	Roseland	July 20, '20
Polychrosis viteana Clem.	Grape berry moth	Rutherford	Sept. 16,
Polychrosis viteana Clem.	Grape berry moth	Plainfield	June 3, '21
Porthetria dispar L.	Gipsy moth	White House	June 21,
Samia cecropia Linn.	Cecropia moth	Haddonfield	Feb. 21,
Samia cecropia Linn.	Cecropia moth	Morganville	April 29,
Sanninoidea exitiosa Say	Peach tree borer	Bound Brook	July 14, '20
Sanninoidea exitiosa Say	Peach tree borer	Riverton	Sept. 27,
Sanninoidea exitiosa Say	Peach tree borer	Moorestown	Nov. 11,
Sanninoidea exitiosa Say	Peach tree borer	Palmyra	Nov. 12,
Sanninoidea exitiosa Say	Peach tree borer	Woodcliff Lake	Nov. 18,
Sanninoidea exitiosa Say	Peach tree borer	Lynchburg, Va.	Dec. 9,

Lepidoptera—Continued

Latin Name	*Common Name*	*Locality*	*Date*
Sanninoidea exitiosa Say	Peach tree borer	White Plains, N. Y.	Feb. 25, '21
Sanninoidea exitiosa Say	Peach tree borer	Palmyra	Feb. 27,
Sanninoidea exitiosa Say	Peach tree borer	Hampton	Feb. 28,
Sanninoidea exitiosa Say	Peach tree borer	Melrose Highlands, Mass.	Feb. 28,
Sanninoidea exitiosa Say	Peach tree borer	Philadelphia, Pa.	Feb. 28,
Sanninoidea exitiosa Say	Peach tree borer	Trenton	Feb. 28,
Sanninoidea exitiosa Say	Peach tree borer	New York City	Mar. 3,
Sanninoidea exitiosa Say	Peach tree borer	Reading, Pa.	Mar. 3,
Sanninoidea exitiosa Say	Peach tree borer	Sweetwater, Tenn.	Mar. 4,
Sanninoidea exitiosa Say	Peach tree borer	Westwood	Mar. 4,
Sanninoidea exitiosa Say	Peach tree borer	Boyertown, Pa.	Mar. 6,
Sanninoidea exitiosa Say	Peach tree borer	New Egypt	Mar. 8,
Sanninoidea exitiosa Say	Peach tree borer	Palmyra	Mar. 8,
Sanninoidea exitiosa Say	Peach tree borer	Minotola	Mar. 9,
Sanninoidea exitiosa Say	Peach tree borer	Mullica Hill	Mar. 11,
Sanninoidea exitiosa Say	Peach tree borer	Westmont	Mar. 11,
Sanninoidea exitiosa Say	Peach tree borer	Newark	Mar. 12,
Sanninoidea exitiosa Say	Peach tree borer	Cleveland, O.	Mar. 14,
Sanninoidea exitiosa Say	Peach tree borer	Elizabeth	Mar. 16,
Sanninoidea exitiosa Say	Peach tree borer	Long Branch	Mar. 16,
Sanninoidea exitiosa Say	Peach tree borer	Oak Lane, Pa.	Mar. 17,
Sanninoidea exitiosa Say	Peach tree borer	Pedricktown	Mar. 17,
Sanninoidea exitiosa Say	Peach tree borer	Bound Brook	Mar. 18,
Sanninoidea exitiosa Say	Peach tree borer	New York City	Mar. 19,
Sanninoidea exitiosa Say	Peach tree borer	Philadelphia, Pa.	Mar. 21,
Sanninoidea exitiosa Say	Peach tree borer	Verona	Mar. 22,
Sanninoidea exitiosa Say	Peach tree borer	Summit	Mar. 23,
Sanninoidea exitiosa Say	Peach tree borer	New Albany, Ind.	Mar. 24,
Sanninoidea exitiosa Say	Peach tree borer	Williamstown	Mar. 25,
Sanninoidea exitiosa Say	Peach tree borer	Bloomfield	Mar. 26,
Sanninoidea exitiosa Say	Peach tree borer	Metuchen	Mar. 26,
Sanninoidea exitiosa Say	Peach tree borer	Reading, Pa.	Mar. 29,
Sanninoidea exitiosa Say	Peach tree borer	New Brunswick	Mar. 30,
Sanninoidea exitiosa Say	Peach tree borer	Ridgewood	Mar. 31,
Sanninoidea exitiosa Say	Peach tree borer	Williamstown	Mar. 31,
Sanninoidea exitiosa Say	Peach tree borer	Metuchen	April 1,
Sanninoidea exitiosa Say	Peach tree borer	Cedar Crest	April 2,
Sanninoidea exitiosa Say	Peach tree borer	Dunellen	April 5,
Sanninoidea exitiosa Say	Peach tree borer	Haddonfield	April 5,
Sanninoidea exitiosa Say	Peach tree borer	New York City	April 6,
Sanninoidea exitiosa Say	Peach tree borer	South River	April 9,
Sanninoidea exitiosa Say	Peach tree borer	New York City	April 12,
Sanninoidea exitiosa Say	Peach tree borer	Philadelphia, Pa.	April 12,

Lepidoptera—Continued

Latin Name	*Common Name*	*Locality*	*Date*
Sanninoidea exitiosa Say	Peach tree borer	Whippany	April 12,
Sanninoidea exitiosa Say	Peach tree borer	Bloomfield	April 13,
Sanninoidea exitiosa Say	Peach tree borer	New York City	April 13,
Sanninoidea exitiosa Say	Peach tree borer	Salem	April 16,
Sanninoidea exitiosa Say	Peach tree borer	Blue Anchor	April 18,
Sanninoidea exitiosa Say	Peach tree borer	Merchantville	April 18,
Sanninoidea exitiosa Say	Peach tree borer	Lebanon	April 19,
Sanninoidea exitiosa Say	Peach tree borer	New York City	April 19,
Sanninoidea exitiosa Say	Peach tree borer	New York City	April 19,
Sanninoidea exitiosa Say	Peach tree borer	Trenton	April 20,
Sanninoidea exitiosa Say	Peach tree borer	Chambersburg, Pa.	April 21,
Sanninoidea exitiosa Say	Peach tree borer	Mt. Carmel, Pa.	April 21,
Sanninoidea exitiosa Say	Peach tree borer	New York City	April 21,
Sanninoidea exitiosa Say	Peach tree borer	New York City	May 4,
Sanninoidea exitiosa Say	Peach tree borer	Orange	June 18,
Sanninoidea exitiosa Say	Peach tree borer	Millville	June 21,
Sanninoidea exitiosa Say	Peach tree borer	Elizabeth	June 22,
Sanninoidea exitiosa Say	Peach tree borer	Dover	June 23,
Sanninoidea exitiosa Say	Peach tree borer	Titusville	June 23,
Sanninoidea exitiosa Say	Peach tree borer	Elizabeth	June 24,
Sanninoidea exitiosa Say	Peach tree borer	Hillside, Mich.	June 24,
Sanninoidea exitiosa Say	Peach tree borer	Sodus, N. Y.	June 24,
Sanninoidea exitiosa Say	Peach tree borer	Ridgewood	June 30,
Telea polyphemus Cram.	Polyphemus moth	Morganville	April 29,
Thyridopteryx ephemeræformis Steph.	Bag worm	Trenton	July 18, '20
Thyridopteryx ephemeræformis Steph.	Bag worm	Millville	July 28,
Thyridopteryx ephemeræformis Steph.	Bag worm	Audubon	Aug. 29,
Thyridopteryx ephemeræformis Steph.	Bag worm	Long Branch	Sept. 17,
Thyridopteryx ephemeræformis Steph.	Bag worm	Atco	Nov. 12,
Thyridopteryx ephemeræformis Steph.	Bag worm	Berlin	Jan. 7, '21
Thyridopteryx ephemeræformis Steph.	Bag worm	Beverly	Feb. 1,
Thyridopteryx ephemeræformis Steph.	Bag worm	Vineland	Feb. 22,
Thyridopteryx ephemeræformis Steph.	Bag worm	Grenloch	Mar. 23,
Thyridopteryx ephemeræformis Steph.	Bag worm	Haddonfield	April 7,
Thyridopteryx ephemeræformis Steph.	Bag worm	Hackensack	April 18,
Thyridopteryx ephemeræformis Steph.	Bag worm	Trenton	May 5,
Tinea pellionella Linn.	Common clothes moth	Dover	Feb. 22,
Tinea pellionella Linn.	Common clothes moth	Chatham	April 22,
Tortrix fumiferana Clem.	Spruce bud moth	Morristown	June 2,
Zeuzera pyrina Fab.	Wood Leopard moth	Springfield	April 11,
Zeuzera pyrina Fab.	Wood Leopard moth	Elizabeth	April 17,

Hymenoptera

Latin Name	*Common Name*	*Locality*	*Date*
Abia americana Cress.	Saw fly	Morristown	June 6,
Agapostemon virescens Fab.	Solitary bee	Morris Plains	June 20,
Andricus clavulus O. S.	White oak club gall	Englewood	June 28,
Andricus petiolicola Bass.	Oak leaf stalk gall	Englewood	June 28,
Andricus seminator Harr.	Wool sower	Ridgewood	May 19,
Apis mellifera Linn.	Honey bee	Ridgewood	Oct. 9, '20
Apis mellifera Linn.	Honey bee	Vineland	Mar. 1, '21
Apis mellifera Linn.	Honey bee	Jamesburg	Mar. 2,
Apis mellifera Linn.	Honey bee	Philadelphia, Pa.	April 4,
Apis mellifera Linn.	Honey bee	Paterson	April 7,
Apis mellifera Linn.	Honey bee	Coyetsville	April 25,
Apis mellifera Linn.	Honey bee	Summit	April 27,
Apis mellifera Linn.	Honey bee	Thorofare	April 28,
Apis mellifera Linn.	Honey bee	Imlaystown	June 8,
Apis mellifera Linn.	Honey bee	Somerville	June 8,
Callirhytis tumifica O. S.	Midrib tumor gall	Englewood	June 28,
Formicidæ sp.	Ants	Millington	Sept. 25, '20
Formicidæ sp.	Ants	Bayville	May 31, '21
Formicidæ sp.	Ants	Elizabeth	June 2,
Formicidæ sp.	Ants	Trenton	June 2,
Formicidæ sp.	Ants	Paterson	June 7,
Formicidæ sp.	Ants	Elizabeth	June 25,
Monophadnoides rubi Harr.	Raspberry saw fly	Mays Landing	May 19,
Ophion sp.	Ichneumon fly	Newton	Jan. 19,
Pteronus ribesi Scop.	Currant worm	Belleville	May 31,
Tenthredinidæ sp.	Saw fly	Bridgeton	July 21, '20
Tenthredinidæ sp.	Saw fly	Blairstown	Sept. 28,
Vespa crabro L.	European hornet	Glassboro	Sept. 28,
Vespa crabro L.	European hornet	Dover	Dec. 16,
Xiphydria maculata Say	Saw fly	Plainfield	April 26, '21

Siphonoptera

Ctenocephalus canis Curt.	Dog flea	Lover, Dela.	April 19,
Ctenocephalus canis Curt.	Dog flea	Lover, Dela.	April 27,
Ctenocephalus canis Curt.	Dog flea	New Brunswick	June 6,

Diptera

Aedes stimulans Wlk.	Brown woods mosquito	Newark	April 27,
Aedes stimulans Wlk.	Brown woods mosquito	Newark	May 2,
Aedes stimulans Wlk.	Brown woods mosquito	Passaic	May 4,

Diptera—Continued

Latin Name	Common Name	Locality	Date
Cecidomyia caryæcola O. S.	Hickory seed gall	Englewood	July 13, '20
Cecidomyia pomum W. & R.	Grape apple gall	Ridgewood	Dec. 24,
Cecidomyia tubicola O. S.	Gall midge	Crosswick	June 11, '21
Cecidomyia verrucicola O. S.	Linden wort	Convent	May 31,
Cecidomyia verrucicola O. S.	Linden wort	Crosswick	June 11,
Cincticornia pilulæ O. S.	Oak pill gall	Plainfield	Aug. 6, '20
Cincticornia pilulæ O. S.	Oak pill gall	Convent	Aug. 12,
Cincticornia pilulæ O. S.	Oak pill gall	Millburn	Aug. 12,
Cincticornia pilulæ O. S.	Oak pill gall	New York City	Oct. 23,
Culicidæ sp.	Mosquito	New York City	June 2, '21
Diarthronomyia hypogæ Lw.	Chrysanthemum midge	Newton	April 1,
Lasioptera vitis O. S.	Grape tomato gall	Maywood	June 7,
Lasioptera vitis O. S.	Grape tomato gall	Perth Amboy	June 9,
Lasioptera vitis O. S.	Grape tomato gall	Locust	June 11,
Lasioptera vitis O. S.	Grape tomato gall	South Orange	June 17,
Monathropalpus buxi Lab.	Boxwood leaf miner	Little Silver	Aug. 25, '20
Phorbia brassicæ Bouche	Cabbage maggot	Pitman	Aug. 2, '20
Phorbia brassicæ Bouche	Cabbage maggot	Elizabeth	Feb. 21, '21
Phorbia brassicæ Bouche	Cabbage maggot	Haddonfield	Feb. 23,
Phorbia brassicæ Bouche	Cabbage maggot	Medford	April 8,
Phorbia ceparum Meig.	Onion maggot	Bridgeton	April 9,
Phorbia ceparum Meig.	Onion maggot	Vestal, N. Y.	April 10,
Phorbia ceparum Meig.	Onion maggot	Matawan	May 31,
Phorbia ceparum Meig.	Onion maggot	New York City	June 18,
Phorbia fuscіceps Zett.	Seed corn maggot	Haddonfield	May 9,
Pollenia rudis Fab.	Cluster fly	Annandale	Oct. 29, '20
Phytomza chrysanthemi Kowz.	Marguerite fly	Quinton	May 21,
Psila rosæ Fab.	Carrot rust fly	Paterson	June 11,
Tabanus lasiophthalmus Macq.	Black-striped horse fly	Somerville	June 11,

INSECTS OF THE YEAR

Plant Lice

The orchard plant lice of the present year have done more serious harm than last, although the number of eggs on the apple trees have been materially less this year than last. The principal species last year was the oat aphis (*Aphis avenae*). This year the rosy aphis (*Aphis sorbi*) and green apple aphis (*Aphis pomi*) were present in much larger numbers, and the green especially has been very persistent. Wherever the rosy aphis was not controlled, the apples are knotted and knarled and never will reach marketable condition. For about three or four years back the green apple aphis has been in the habit of reappearing in mid-summer upon the water sprouts and the tender growing portions of the tree in sufficient numbers to curl the foliage and stain the fruit. This year the green aphis has been particularly noticeable in that respect.

Plant lice on vegetable products, particularly on peas, tomatoes, and potatoes have been very abundant and large damage has been done by them. The species on peas is the pea aphis (*Macrosiphum pisi*) and on potatoes and tomatoes is the pink and green aphis (*Macrosiphum solanifolii*).

The woolly louse (*Schizoneura lanigera*) has been present in unusual numbers and has occasioned much concern, but little, if any, serious damage has been done by it.

The cherry louse (*Myzus cerasi*) has been present in the usual numbers and has done about the usual amount of damage.

Pear Psylla

The pear psylla (*Psylla pyricola*) has continued as abundant as it has been in the last few years and has done large damage to the pear crop.

Codling Moth

The record of the codling moth (*Carpocaspa pomonella*) during the year just past is quite equivalent to that of the last. Many orchardists are failing to obtain satisfactory control.

Oriental Peach Moth

The oriental peach moth (*Laspeyresia molesta*) exhibited during the summer season of 1920 a most remarkable increase in number and in extent of injury. Heretofore in our experience this insect has limited its attacks largely to the growing shoots of the peach and has done little harm to the fruit, but during the summer season of 1920 it attacked the fruit even very early in the season and destroyed in badly infested orchards a large proportion of the fruit. Peaches apparently ripe and in good condition were picked, packed and placed in the market. When they reached the ultimate consumer and were opened for use, the caterpillar of this moth was found inside. Studies looking toward methods of controlling this moth are continued.

The Rose Bug

The rose bug (*Macrodactylus subspinosus*) has been unusually abundant and has appeared through sections on the red shale where is has not been noted for many years. The self-boiled lime-sulfur treatment has again demonstrated its efficiency.

Potato Flea Beetle

The potato flea beetle (*Epitrix cucumeris*) has been present during the forepart of the season of 1921 in larger numbers than at any time during the last seven or eight years. It has been prevalent very largely all over the state and in some parts has done very serious harm to the potato crop. Measures of complete control are still lacking. Coating with Bordeaux serves to eliminate a large part of the injury.

Plum Curculio

The plum curculio (*Conotrachelus neuphar*) has been present in about the same numbers as in previous years, and where fruit of apple, peach and plum has been unprotected has done large damage. A complete coating of common spray mixtures maintained throughout the period of attack seems to afford satisfactory protection.

Green Japanese Beetle

The green Japanese beetle (*Popilia japonica*) spread during the past season until it was known to occupy an area of approximately seventy square miles on both sides of the Delaware River from Camden and Philadelphia north. The work of controlling this insect is carried out at the Japanese Beetle Laboratory by a cooperative organization under the control of the New Jersey State Department of Agriculture and the United States Department of Agriculture.

As the effort to exterminate this insect had to be given up the work has been devoted to the delay of spread by means of quarantine carefully enforced, to the discovery of artificial methods of control and to the introduction and establishment of natural enemies. A well equipped laboratory at Cinnaminson, N. J., is maintained, and here the various kinds of investigations looking toward control are being ably and conscientiously prosecuted.

Gipsy Moth

The gipsy moth (*Porthetria dispar*) was discovered by agents of the New Jersey State Department of Agriculture in late June of last year working in Duke's Park at Somerville, N. J. An effort looking toward the determination of territory covered by the infestation and to the formulation of plans for its control and possibly eventual extermination was undertaken. It was soon decided that at least a hundred square miles of territory within the boundaries of Duke's Park and adjacent thereto were infested. It was also found that surplus stock from the park plantings had been distributed widely. The work of tracing out these shipments was begun promptly and the preparation of the estimates for the control and extermination work against the insect was pushed rapidly to completion.

Only very limited funds in the United States Department of Agriculture and practically none whatever in the New Jersey State Department of Agriculture were available; consequently, the accomplishment above set forth was as much as could be expected.

On November 8, 1920, the Legislature made immediately available a sum of $112,000. With this sum a force of trained men from the gipsy moth areas of New England were brought into New Jersey and the work of scouting and treating egg-masses was undertaken. During December, January and February a force of nearly eighty men was continued. In March additional funds from the United States Department of Entomology became available and the force was increased to 200.

In the meantime 11 truck-mounted sprayers were purchased and delivered on the ground ready for spring and summer spraying. A similar spraying machine of larger capacity was sent down from New England by the United States Gipsy Moth Service.

After the caterpillar hatch the spraying machines worked for a period of 55 days delivering fully 75 tons of arsenate of lead and covering an area of not less than about 2,500 acres. Some of this area was covered twice and in some cases three times. In addition, the eight or nine outlying areas which scouting had uncovered were sprayed and taken care of in the same way as the main area.

As the matter stands, after about 7 months of intensive work it is known that the main area involves about 410 square miles, only the center of which is infested heavily, the outlying portions showing here and there an egg mass. It is also known that small and recent infestations exist at Deal Beach, Elizabeth, South Orange, Glen Rock, Paterson, Wyckoff, Chatham, Madison and Mendham. It is also known that at the end of the spraying season in June, caterpillars were scarce and very difficult to find in even the most heavily infested portion of the main area. Thus in one season's work the insect seems to have been brought under such control that no stripping of tree foliage has taken place and that caterpillars are hard to find.

A great showing has been made this year, but the intensive, difficult work of extermination still remains to be accomplished. It seems reasonable, however, to conclude that with adequate support actual extermination can be brought about.

This work is conducted cooperatively by the New Jersey State Department of Agriculture and the United States Department of Agriculture, and the organization utilized in doing the work is a part of the general gipsy moth organization of the Bureau of Entomology of the United States Department of Agriculture.

INVESTIGATIONS

Climate and Insect Investigations

Utilizing the methods of atmospheric moisture conditioning outlined on pages 442-444 of the Annual Report for 1919, three series of experiments have been completed on the effect of atmospheric moisture upon the rate of metabolism of the common bean weevil *Bruchus obtectus*.

In each of the three series of experiments five containers were employed for each selected percentum of atmospheric moisture. Each of the five containers received 25 adult beetles as nearly evenly divided between sexes as was practicable. Thus each selected percentum of atmospheric moisture in each of the three sets of experiments started with 125 adult weevils. The succeeding progeny in the five containers ranged from none in very low atmospheric moisture to over 1,200 individuals in more favorable atmospheric moisture. The factor of individual variations in the response was in this way reduced to the lowest practicable minimum.

The length of time necessary for certain transformations to take place was adopted as the measure of the response of the bean weevil to these varying percentages of atmospheric moisture. It was found to be impracticable to check this type of measure by the measurement of the evolution of carbon dioxide, because the food of the insect, being a living plant, threw off considerable quantities of carbon dioxide on its own account and obscured the evolution of that gas from the insects under observation.

Two curves were derived (fig. 1), the first representing the period of time from the laying of the egg to the formation of the pupa, and the second representing the period of time from the laying of the egg to the emergence of the adult. The first curve has proven to be very smooth and definite, while the second curve shows very pronounced variations. No individuals succeeded in reaching maturity in an atmospheric moisture of less than 1 per cent, and very few individuals succeeded in an atmospheric moisture of 7.1 per cent. Comparatively few succeeded in reaching maturity in an atmospheric moisture of 25.9 per cent. In these three cases the only apparent cause was the low atmospheric humidity. In both 89.7 per cent and approximately 100 per cent in spite of everything that could be done in the way of sterilizing the food, fungi developed and always greatly reduced the number, and in some cases, utterly prevented the insects from reaching maturity. Such as did reach maturity in the 100 per cent atmospheric moisture seemed to be considerably delayed possibly by the action of the fungi. The data from these sets of experiments, as those derived from previous ones, indicate that the optimum atmospheric moisture for the bean weevil lies somewhere between 80 and 89 per cent, and is located in that percentum which is just far enough below 89 to prevent the development of injurious fungi.

As is shown by the curve based on the length of period from egg to pupa the value of 1 per cent increases in atmospheric moisture at any point between 7.1 per cent and 80 per cent is approximately two-hundredths of a day. Of course, there is considerable variation in this evaluation of the 1 per cent increase, but the variation is such as to indicate that that figure is not very far from the facts. The variation is thought to be due in all probability to the direct and possibly to the indirect effect of certain of the salts which seemed in some cases to have a retarding and in other cases to have an accelerating action. These variations as shown in the curve representing the period from egg to pupa became much more pronounced in the curve representing the period from egg to adult. As yet the writer has had no opportunity to evaluate this factor, and consequently has not been able to smooth the curves. The curve representing the period from egg to adult cannot be considered as representing in a satisfactory manner the effect of the different percentages of atmospheric moisture until it has been smoothed in that way. Nevertheless, the writer believes it is fair to assume that the curve representing the period from the egg to pupa is already sufficiently smooth to give a pretty accurate idea of the effects of the different percentages of atmospheric humidity on the rate of development of this insect.

As the next step in this investigation it is proposed to evaluate the retarding and accelerating effect of certain of these salts and to check the measuring stick used in these sets of experiments by the carbon-dioxide index.

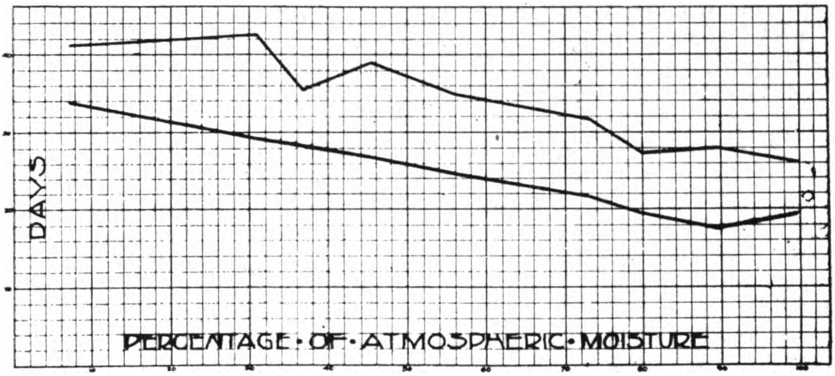

FIG. 1. CURVES SHOWING EFFECT OF PROPORTION OF ATMOSPHERIC MOISTURE ON DEVELOPMENT OF THE BEAN WEEVIL.

LOWER CURVE REPRESENTS PERIOD FROM LAYING OF EGG TO FORMATION OF PUPA.

UPPER CURVE REPRESENTS PERIOD FROM LAYING OF EGG TO EMERGENCE OF ADULT.

Through the agency of an undergraduate student, Walter E. Fleming, an effort was made to apply the effects of low atmospheric moisture for protection of seeds against seed-infesting insects. At the outset the effect of the loss of water on the viability of corn, beans and peas was determined. The results are set forth in table 1.

Table 1

Effect of Moisture Content of Viability of Beans, Corn and Peas

DATE	Water Content			Water Lost			Seeds that Germinated		
	Beans	Corn	Peas	Beans	Corn	Peas	Beans	Corn	Peas
	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent
3- 5-'21	11.57	14.39	11.48						
3-15-'21				21.75	71.32	44.30	102.7	105.4	83.5
3-22-'21				44.04	75.51	65.54	92	95	80
3-30-'21				44.52	90.09	67.14	83	97	69
4- 5-'21				49.20	85.18	71.44	67	81	59
4-12-'21				55.54	90.05	74.98	65	78	43
4-19-'21				55.92	92.72	76.84	58	87	50
4-26-'21				55.45	92.50	75.25	63	96	58
5- 3-'21				57.15	90.50	81.92	71	56	52

Thus it appears that the reduction in water content is accompanied with a slow decrease in the viability and that when the water content of beans, corn and peas is reduced more than 45 per cent, 90 per cent and 65 per cent, respectively, the decrease of germination becomes serious.

The hygroscopic power of certain common cheap substances such as calcium oxide, calcium chloride, calcium hydroxide and Milltown ball clay No. 9, was then determined, and it was found that an exposure of these substances from April 18 to April 25 to an air stream containing 73 per cent of atmospheric moisture showed a gain for calcium chloride of 126.8 per cent, for calcium oxide 30.5 per cent, for calcium hydroxide 0.15 per cent and for clay 0.15 per cent.

The effect of placing bean seeds in containers with definite amounts of each of these substances, but separated from the substance in question by a thick layer of cotton, was then determined. The results are set forth in table 2.

Table 2

Effect of Certain Materials upon the Germination of Beans When Placed in the Same Container but Separated by Cotton

Proportion Bean: Substance		CaO		$CaCl_2$		$Ca(OH)_2$		Clay	
Beans separated by cotton	Adults Start	Adults Finish	Holes	Adults Finish	Holes	Adults Finish	Holes	Adults Finish	Holes
4:1	15	35	50	..	..	30	257	..	..
2:1	15	15	14	36	50	190	184	15	27
1:1	15	15	0	17	4	18	147	15	0
1:2	15	15	0	30	24	15	10	15	0
1:4	15	15	0	15	0	175	199	15	0
Control	5	5	60						

Thus it appears that calcium oxide is the only substance of the four which exhibits much effect as a dehydrator, and the beans treated with that substance were cracked and somewhat broken up.

The effect of mixing these substances with various proportions directly with the beans was then tried. The results are set forth in table 3.

Table 3

Effect of Certain Materials upon the Germination of Beans When Mixed Together

Proportion Bean : Substance		CaO		$CaCl_2$		$Ca(OH)_2$		Clay	
Beans Mixed	Adults Start	Adults Finish	Holes	Adults Finish	Holes	Adults Finish	Holes	Adults Finish	Holes
32:1	5	25	30			70	66		
16:1	5	5	0	5	1	10	5	5	0
8:1	5	5	0	5	0	5	0	5	0
4:1	5	5	0	5	13	5	0	5	0
2:1	5	5	0	5	0	6	1	5	0
1:1	5	5	0	5	0	6	1	5	0

Thus it appears that the calcium oxide was rather effective but cracked a small proportion of the beans; calcium chloride liquified or hardened and in either case became impossible; calcium hydroxide was only partially effective while clay in practically all proportions tried seemed to prevent beetle injury and to leave the seed in good condition.

In summarizing the results of this work it may be said that none of the substances seem to be satisfactory as dehydrators and that Milltown ball clay No. 9 seems to be the best from all points of view when used as a contact protection for the seed.

Dusting Investigations

Much has been written about the relative efficiency of materials applied as a dust to apples and peaches for the control of insects and diseases as compared with materials applied in water for the same purposes. On the peach, within the limits of New Jersey, it seems that materials applied dry are almost as efficient in the control of the common insects as are materials applied in water.

The data relative to the efficiency of dusts as compared with liquid treatments on the peach are set forth in table 1.

Table 1

Comparison of Dust and Spray in Control of Curculio on the Peach

Year	Location	Curculio Present		
		Check	Dust	Liquid
		per cent	per cent	per cent
1913	Glassboro	29.10	4.40	5.50
1913	Vineland	70.30	43.30	31.60
1914	Vineland	.....	3.68	3.88
1917	*Haddonfield			
Average		49.70	17.12	13.66

*No record.

On the apple the same statement cannot be made, for we find through a period of years approximately twice as much injury by codling moth and curculio where the fruit has been protected by materials applied dry than where fruit has been protected by materials applied wet. The facts relative to this matter are set forth in table 2.

Table 2

Comparison of Dusting and Spraying on the Apple

Year	Number of Experiments	Location	Sound Fruit			Curculio			Codling Moth								
									First Brood			Second Brood			Total		
			C*	D*	S*	C	D	S	C	D	S	C	D	S	C	D	S
			per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent
1913	1	Glassboro	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1914	1	Cranbury	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.7	4.1	2.7
1919	1	Moorestown	.....	.....	.....	.....	20.0	9.5	....	15.0	7.4	....	50.0	22.9	.....	65.0	30.3
1920	1	Moorestown	58.5	73.7	97.45	28.3	19.8	7.1	4.2	1.4	1.5	7.4	7.7	2.5	11.6	8.8	4.1

* Legend: C = Check, D = Dust, S = Spray.

Examination of this table shows that in the 1913 tests no data on either curculio or codling moth were obtained because there was not enough of either insect to give results. In 1914 the curculio was not sufficiently abundant to give data and the codling moth on the untreated trees attacked only 4.7 per cent of the total fruit.

In 1919, however, there was an abundance of both codling moth and curculio and in 1920 the curculio was present in large numbers and the codling moth in fair numbers.

Our experience with materials applied dry on the apple indicates distinctly that the reason for their comparative failure to effect control is to be found in the fact that they remain upon fruit and foliage for only a fraction of the time during which the materials applied wet are present in an effective condition.

All this indicates that if the application of materials for the protection of the apple from insect attack is highly desirable in itself, as it seems to the writer it surely is, the present dust materials must be investigated fundamentally with a view to making them stick and to making them effective against not only chewing insects but also sucking forms. It has been distinctly shown in New Jersey that nicotine-impregnated dusts will destroy high percentages of the oat aphis and the apple leaf hopper as set forth in tables 3 and 4.

Table 3

Effect of Nicotine-Impregnated Dusts on Leaf-Hopper on the Apple

Date	Block	Row	Number of Leaves	Number of Hoppers	Killing Agent
6-8-'20	1	2	1,000	15	Nicotine, 0.5 per cent applied.
6-8-'20	2	2	1,000	7	Nicotine, 1 per cent applied.
6-8-'20	3	1	1,000	7	Nicotine, 3 per cent applied.
6-8-'20	3	3	1,000	32	Nicotine, 3 per cent possible floating.
6-8-'20	4	2	1,000	76	Owner's treatment.
6-8-'20	5	2	1,000	4	Nicotine, ¾ pt. to 50 gal.
6-8-'20	4	Checks	1,000	108	None.

From Demonstration Blocks at Maple Shade.

6-8-'20	Original infestation estimated	3,000	9,000	
6-8-'20	Row 3, Extension Specialist	3,000	90	Nicotine, ¾ pt. to 50 gal.
6-8-'20	Row 8, Experimentalist	3,000	25	Nicotine, ¾ pt. to 50 gal.
6-8-'20	Row 13, Owner	3,000	299	Nicotine, ¾ pt. to 50 gal.

Table 4

Effect of Different Sprays and Dusts on Apple Aphis Species Aphis Avenae

Date	Block	Rows	Number of Buds	Number of Lice	Number of Lice per Bud	Killing Agent
4-24-'20	1	1-4	200	27	0.130	Nicotine dust, 0.5 per cent
4-24-'20	2	1-4	200	17	0.085	Nicotine dust, 1 per cent
4-24-'20	3*	...	...	..	.....	Nicotine dust, 3 per cent
4-24-'20	4	1-4	200	76	0.380	Lime-sulfur, 1 to 9
4-24-'20	5	1-3	200	10	0.050	Lime-sulfur, 1 to 9 Nicotine, 40 per cent, ¾ pt. to 50 gal.
4-29-'20	1	1-4	200	39	0.190	Nicotine dust, 0.5 per cent
4-29-'20	2	1-4	200	10	0.050	Nicotine dust, 1 per cent
4-29-'20	3	1, 2	200	1	0.005	Nicotine dust, 3 per cent
4-29-'20	4	3, 4	200	9	0.045	Lime-sulfur, 1 to 40 Nicotine, 40 per cent, ¾ pt. to 50 gal.
4-29-'20	5	1, 3	400	0	0.000	Lime-sulfur, 1 to 40
4-29-'20	5	2, 4	400	0	0.000	Lime-sulfur, 1 to 40 Nicotine, 40 per cent, ¾ pt. to 50 gal.

* No counts.

Investigations both on dust stickers and on contact dusts of various kinds are now going on, but the progress made is not sufficient to justify formal reporting.

Orchard Insect Investigations

Codling Moth

The work against this insect along the line of brood studies and methods of control has been continued.

The results of the brood studies of 1919, 1920 and 1921 to June 30 are set forth in figure 2.

Thus far the evidence indicates the existence of only two broods, and it may be said that the indications in 1921 are that the same number of broods will be found as in the years 1919 and 1920. This brood study is conducted in the region of Glassboro and Moorestown, both of which lie approximately opposite Philadelphia, and judging from the records of 1919 the difference between the broods at Moorestown and at Glassboro is infinitesimal. The codling moth at New

Brunswick exhibited much less virulence in the second brood and in the northwestern section of the state the second-brood work is almost if not quite negligible.

The period of entry by the first brood of the codling moth is obviously variable both in length and in seasonal location. This observation merely bears out the work of the majority of all other investigators of the codling-moth broods. On the other hand, the period of entry by worms of the second brood seems to be quite similar both in length and in seasonal location. This again bears out observations elsewhere in the United States.

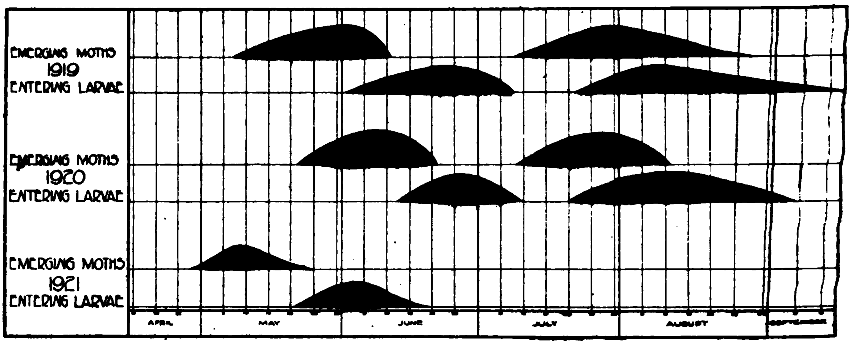

FIG. 2. DIAGRAM SHOWING RESULT OF BROOD STUDIES ON THE CODLING MOTH, 1919, 1920 AND 1921.

In the matter of control, the spraying as it is now practiced among the New Jersey orchardists is quite efficient for the control of the worms entering the blossom end of the apple, but the same point cannot be made for the control of the worms entering the sides of the apples in the region of Moorestown and southward. The early apples, of course, are exposed primarily to damage by the first brood, but the late apples are attacked by both broods.

The idea, not uncommon among entomologists, that a thorough control of the worms entering the blossom end will result in a pretty satisfactory control of the worms of the second brood apparently does not hold in those regions of the state which are badly infested by both broods. With the practice of our ordinary spraying schedules in a badly infested orchard we have reason to expect about twice as much damage by the second as by the first brood. This is borne out by data obtained during the several years that work on the control of the codling moth has been going forward.

In the report of last year the entomologist described a set of experiments which were carried out in accordance with a plan drawn up by representatives of New York, Connecticut, Pennsylvania, the United States Bureau of Entomology and New Jersey. The results of this experiment are set forth in table 1.

Table 1

Results of Experiment in the Control of the Codling Moth

Year	Number of Experiments	Location	Sound Fruit			Curculio			Codling Moth						Total		
									First Brood			Second Brood					
			C*	D*	S*	C	D	S	C	D	S	C	D	S	C	D	S
			per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent
1920	1	Moorestown	58.5	73.7	97.45	28.3	19.8	7.1	4.2	1.4	1.5	7.4	7.7	2.5	11.6	8.8	4.1

* Legend: C = Check, D = Dust, S = Spray.

Wherever the codling moth is present in unusual abundance and fully double brooded it seems that the control exerted by the spraying schedule of the station is unsatisfactory. In view of this fact, this year a set of experiments were arranged for the purpose of determining what changes in the spraying schedule must be made to effect control of the side worms of both broods and what the economic advantage of such a procedure would amount to.

Three blocks each 5 rows wide and approximately 10 rows long were selected in a 12-year-old Winesap orchard at Glassboro. Block 1 was to receive the schedule. Block 2 was to receive the schedule plus such accessory sprayings as might be necessary to maintain the coating of poison throughout the periods covered by the entry of each brood. Block 3 was to receive the schedule throughout the period of the first brood, but throughout the period of entry of the second brood was to receive such accessory sprayings as were necessary to insure the maintenance of a coating to the fruit.

Of course, by June 30 the results on the first brood only were visible and they were not complete, but at the date of the writing of this report the entry period of the first brood has gone by and we find that on blocks 1 and 3 a considerable percentage of the apples has been entered through the side, but that on block 2 entry of the apple by the codling moth is exceedingly scarce and very difficult to find. The final results of this test will be set forth in the next annual report.

Experiments With Various Substances for the Control of the Peach-Tree Borer, Sanninoidea Exitiosa Say

ALVAH PETERSON

Introduction

During the past season the writer continued to devote the greater portion of his research time to studies on control measures for the peach-tree borer. The following substances were tried: "Gipsy moth tree-banding material," several asphalt compounds, "Borowax," pine-tar, "Borercide," hydrated lime, sodium sulfo-carbonate, mercuric chloride, sodium cyanide, orthodichlorobenzene and paradichlorobenzene. Some of these products have been used for one or more seasons.

The first four substances named were used exclusively on 1- and 4-year-old peach trees at the horticultural farm. The department of horticulture cooperated with us by furnishing approximately 250 4-year-old trees (St. John and Crawford varieties) and space for 75 1-year old Greensboro peach trees. We wish to express our appreciation for this cooperation. The other products named were used in various orchards throughout the state.

Previous to the writer's studies on the peach-tree borer in New Jersey the departments of entomology and horticulture tried various substances for the control of the peach-tree borer. Among these, asphalt and tar coatings were used. Some of the results obtained were somewhat favorable, consequently it was decided to give these products and others of a similar nature another trial.

Table 1 shows the results of experiments with some of the products tried on 1-year-old (Greensboro variety) and 4-year-old (St. John and Crawford varieties) trees at the horticultural farm. The nature of the application also is shown in the table. All of the trees used in these experiments were carefully "wormed" before the applications were made. The material was applied some time between June 15 and July 1, 1920. It was necessary to reapply some of the substances during July due to the fact that a severe rain and wind-storm destroyed some of the treatments a few days after they were made. During the month of August eggs of the peach-tree borer were placed on all of the treated and check trees, 100 eggs on the 4-year-old trees and 50 on the 1-year-old trees. This insured the experiments against the failure of a natural infestation.

"Gipsy Moth Tree-banding Material"

The table shows that no product used prevented the entrance of all of the worms. The "Gipsy Moth Tree-banding Material" brought about the greatest reduction in the number of larvæ in the tree. The total number of larvæ averaged 2.7 per tree (check trees 6.6 per tree). Most of the larvæ entered the tree above ground. Apparently they were repelled by the soft greasy band and forced to look for an entrance above the treatment. "Gipsy Moth Tree-banding Material" is made from neutral coal-tar oil, hard coal-tar pitch, and rosin oil (see Bul. 899, U. S. Depart. Agr., Bur. Ent.). It remains soft, greasy and slightly sticky to the touch for a considerable period of time when placed on a branch or trunk of a tree at some distance above ground. When a band is placed on the tree adjacent to the ground it collects particles of dirt and after a few weeks the outer surface is somewhat hardened, yet it does not harden enough to crack as the tree expands in growth. Of all the substances used this product best withstood weather conditions and tree growth. It produced small dead spots ¼ to ½ inch in diameter in the living tissue underneath the bands on a few of the 4-year-old trees. Peculiar as it may seem, no injury was seen on the 1-year-old trees.

Asphalt Compounds

Three kinds of asphalt compounds manufactured by the Barber Asphalt Co., Maurer, N. J., were tried; an asphalt putty, a thick asphalt fibre coating and a thin asphalt emulsion which emulsifies in water. All of these products harden upon exposure to air, consequently as the trees expanded in their growth the coatings cracked above and below ground. These materials, also those of the gipsy moth tree-banding material, were applied to the trees in two ways. Some of the trees were coated with a broad band which covered a portion of the tree above and below ground while others were coated with a band which only covered the base of the tree several inches above ground.

The asphalt compounds did not keep the borers out of the tree. The total number of worms in the 4-year-old trees averaged 4.4 to 8.1 borers per tree according to the treatment. This is by no means satisfactory. Furthermore, all of the treatments showed slight, serious or complete kill of the 4-year-old trees according to the treatment. The fibre asphalt coating produced the greatest amount of injury. Again the 1-year-old "Greensboro" trees showed little or no injury from any of the asphalt treatments.

"Borowax"

"Borowax" is a manufactured product which has a strong coal-tar odor. It is sold by J. T. Lovett Co., at Little Silver, N. J. This material was used alone and in combination with sawdust and sand. In experiments 17 and 18 it was placed in a shallow trough about the base of the tree while in experiments 19 to 21 it was mixed with sawdust or sand. The particles of dry sawdust or dry sand were coated with "Borowax," then placed in a trough 3 to 5 inches deep about each tree and covered with a layer of soil ½ inch deep to keep the upper surface from washing. In mixing the "Borowax" with the sawdust or with sand 1 pint of material was sufficient throughly to coat 3 gallons of dry sawdust or 2 gallons of sand. The results of these experiments show the greatest reduction of larvæ per tree where the "Borowax" was used by itself on 4-year-old trees, 4.2 borers per tree; when mixed with sand 5.8 larvæ occurred per tree, and when mixed with sawdust 10.1 larvæ per tree. "Borowax" did not prevent an infestation and it seriously injured or killed 4-year-old trees when it was used by itself as a collar about the tree. Some injury resulted when it was combined with sawdust and sand. During the month of August the trees in experiments 20 and 21 showed a large amount of gum coming from the tree immediately above the treatment. The 1-year-old trees were slightly injured by the "Borowax" alone and in combination with sawdust.

Pine-tar

Pine-tar, a heavy dark liquid, was used in the same way as the "Borowax" (table 1, experiments 22-25). Here again the greatest reduction of borers, 5.6 larvæ per tree, occurred where the pine-tar alone was placed in a trough about the tree while in the experiments where the pine-tar was mixed with the sand and sawdust there were

7.2 and 10.4 larvæ per tree, respectively. The pine-tar was ineffective as a control measure for the peach-tree borer. It produced little or no injury to any of the trees.

The foregoing experiments recorded in table 1 give little or no encouragment for the development of a preventative paint or coating which will keep the borers out of the trees. The table shows that a goodly number of larvæ entered the tree above the point of treatment. In many instances the material acted as a barrier but it did not keep the worms out of the tree. Many of the worms that entered above the treatment worked their way down and into the tree so that they were eventually below ground or directly underneath the treatment. A few larvæ actually entered the tree through some crack in the treatment while others apparently crawled over the bands and entered the tree below the coating. The gipsy moth tree-banding material gave the greatest protection, probably because this product remained soft and greasy most of the time, thus making a more efficient barrier. Even though some of the products listed in table 1 had proven to be satisfactory the most of them would still be impractical as a general control measure on account of their cost and the hard and careful work required to obtain and maintain a satisfactory coating.

The author appreciates the value of a preventative control measure over that of some measure which aims to kill the borers after they have entered the tree, yet our experience to date shows us some seemingly insurmountable difficulties which must be taken into consideration in the development of a preventative measure. Probably the most important of these is the yearly increase in size of the trunk of the tree. This is particularly important in trees of a non-bearing age. Tree growth during the summer destroys the barrier and lays open the bark to attack by the young larvæ. Among numerous other factors one must consider the changes in the weather and the soil conditions during the prolonged period of June 15 to September 15 over which the preventative measure must be in good condition. Rain and wind also play havoc with protective measures.

Hydrated Lime

Hydrated lime was placed next to the base of 10 peach trees (free of worms) in a trough 3 inches deep and 2 inches wide. Five of the trees were 4 years of age and the other five were 2-year-old nursery trees. One hundred eggs were placed on each of the 4-year-old trees and 25 eggs on each of the nursery trees. The 4-year-old trees showed 2.6 worms per tree below ground and 4.1 larvæ per tree above ground, while the 4-year-old check trees showed 6.5 larvæ per tree (below ground only). The treated nursery trees showed 2.0 worms per tree below ground and the check trees showed 6.5 worms per tree. These tests show that hydrated lime reduced but did not prevent an infestation of the peach-tree borer. There was no sign of injury on the treated trees.

"Borercide"

There is in the market today a white powder called "Borercide" which is advertised as a preventative and a destructive insecticide for the peach-tree borer. This powder apparently contains a considerable amount of napthalene. During the past season this material was used in four orchards throughout New Jersey on 75 to 100 trees, varying in age from nursery stock to 12-year-old trees. In August 1 ounce of the "Borercide" was placed about 10 1-year-old nursery trees free of worms and then covered with a thin layer of soil (½ inches deep). Twenty-five eggs were placed on each tree and a later examination in October showed 2.8 larvæ per tree (6.5 larvæ per tree in the check). In another experiment 2 liquid ounces of the material was sprinkled about and adjacent to the trunks of 10 4-year-old trees (free of worms) late in June, 1920. One hundred eggs were placed on each tree in August. In October these trees averaged 4.2 larvæ per tree below the point where the "Borercide" was present. In another orchard 10 heavily infested 4-year-old trees were treated with 1 ounce of the powder early in September. The material was placed against the trees at soil level and covered with several inches of soil as recommended. In 3 weeks the trees were examined and there were 5.2 living larvæ per tree and 0.4 dead larvæ per tree. These and other experiments of a similar nature showed conclusively the ineffectiveness of "Borercide" as an insecticide for the peach-tree borer. E. B. Blakeslee also has shown that napthalene has little or no effect on the peach-tree borer.

"Borercide" produced some injury to trees 4 years of age and younger. Some of the trees showed a dull bluish tinge in the wood adjacent to the cambium. This discoloration may not be serious, yet it is by no means normal. The seriousness of the injury will be more evident next season. "Borercide" retains its odor for a long period when placed in the soil. Applications made in June in a sandy soil gave a distinct odor when the dirt was removed in October.

Mercuric Chloride

Mercuric chloride was tried on a few peach trees. It was thought that this material might be as effective against the peach-tree borer as against the cabbage maggot. In one orchard 10 4-year-old trees were treated at the rate of 2 grams of mercuric chloride to 1 liter of water. Approximately 2 liters of solution were poured into a trough about each infested tree. This treatment killed some of the small larvæ working on the outside of the peach tree but it did not penetrate into the tree and kill the worms located within. Two-year-old nursery trees treated with 1 liter of this solution showed injury. The bark was olive-brown in color. So far as observed the 4-year-old trees were uninjured.

In another set of experiments 1 or 2 grams of mercuric chloride was sprinkled about the base of 5 flowering peach trees 4 years of age. These trees were killed or seriously injured. Even this treatment did not kill all of the borers in the trees, particularly those located in the upper portion of the trunk which was alive. One part of mercuric chloride was mixed with 25 parts hydrated lime and 5 teaspoonfuls were placed in a trough about the base of 5 nursery trees (free of worms) 2 years of age on August 20. Twenty-five eggs were placed on each tree. When the trees were examined in October there were 0.2 larvæ per tree, while check trees showed 6.5 larvæ per tree. This indicates that the mercuric chloride was effective against the newly hatched larvæ. The above experiments with mercuric chloride are preliminary. Further investigation is needed before definite statements can be made concerning the use of this poison as an insecticide for the peach-tree borer.

Sodium Sulfo-carbonate

A few preliminary trials were made with sodium sulfo-carbonate for the control of the peach-tree borer. The Dow Chemical Company of Midland, Michigan, furnished us with a sodium sulfo-carbonate which registered approximately 20° Beaumé. This solution was diluted 1 part to 25 of water and 1 gallon of the diluted solution was poured into a trough about 10 peach trees 4 and 12 years of age. This concentration produced no apparent injury to the trees. The exact effect upon the larvæ is not definitely known. It will require more experiments to determine this point.

Sodium Cyanide

For two years experiments have been conducted with sodium cyanide for the control of the peach-tree borer. This past season no further experiments were conducted but observations were recorded in several orchards where previous treatments had been made. No serious injury was seen in any orchard except one. Here the owner treated approximately 3,000 8-year-old trees with 1 ounce of dry crystalline sodium cyanide (per tree) early in December, 1919. The cyanide was sprinkled about the tree and the dirt piled on top. A considerable number of injured and dead trees were seen during the summer (1920). Those trees which were known to be most heavily infested with borers suffered the most. The above application was made too late in the season for safety. The soil is too cold and wet in December to permit the rapid dispersal and disappearance of the poisonous gas. For further information concerning the use of sodium cyanide for the control of the peach-tree borer, see a paper entitled, "A preliminary report on the use of sodium cyanide for the control of the peach-tree borer (*Sanninoidea exitiosa* Say)," in the Journal of Economic Entomology (v. 13, p. 201-207).

Orthodichlorobenzene

Two manufacturers of paradichlorobenzene furnished us with one and two solutions which contained a high percentage of orthodichlorobenzene. The solutions also contained some paradichlorobenzene, probably not to exceed 12 per cent, and other undetermined ingredients. These solutions were used on approximately 100 trees in several orchards varying in age from 4 to 12 years. One-half to one liquid ounce of the solutions poured on the ground about infested trees and covered with soil gave very effective results in killing the larvæ. Its insecticidal value compares favorably with that obtained by crystals of paradichlorobenzene. In a number of orchards serious injury was produced on trees of all ages when the solution were poured into the soil 2 inches from the tree. The injury is similar to that produced by paradichlorobenzene on young trees. The injury was always most severe when the solution was poured against the bark. The decided difference in the amounts of injury produced by orthodichlorobenzene and paradichlorobenzene may in part be accounted for by the more rapid evaporation of orthodichlorobenzene. It is also possible that the unknown impurities in the solution produced the injury. It will be necessary to use chemically pure solutions to determine the exact effect of orthodichlorobenzene on peach trees.

Paradichlorobenzene

Of all the control measures for the peach-tree borer which the writer has had the opportunity to investigate, paradichlorobenzene gives the greatest promise of becoming a valuable insecticide for the control of the most important peach pest.

Numerous and varied experiments have been conducted with paradichlorobenzene. Space will not permit a review of these experiments in this report. The following statements concerning this product summarizes our present knowledge concerning the use of paradichlorobenzene for the control of the peach-tree borer.

Para-di-chloro-benzene (or Paradichlorobenzol) is a white crystalline solid, which is insoluble in water and vaporizes slowly at ordinary temperatures. The gas given off is much heavier than air and its odor has some resemblance to that of napthalene. The gas is non-poisonous to man but decidedly poisonous to insects when they are exposed to it for a considerable period of time.

Up to date, our experience with paradichlorobenzene shows that it can be used with a considerable margin of safety on trees 6 years of age or older. In a few and exceptional instances old trees, which have been greatly weakened by severe borer attack, have been seriously injured or killed by the gas. Trees younger than 6 years are apt to be injured by prolonged exposures to the gas. This is particularly true of 1- to 3-year-old trees. Recent experiments show that young trees

3 to 6 years of age may be successfully treated with ½ ounce of paradichlorobenzene for 14 to 21 days when the soil temperature under the trees at 6 inches averages 60° to 70° F. and when the soil is somewhat dry (at least not too wet). Ninety per cent or more of the larvæ will be killed. To date no injury has resulted from these short treatments.

Doses of ¾ ounce and of 1 ounce per tree have been found to destroy the borers effectively and yet not injure vigorous trees (6 years of age or older). In many instances doses of ½ ounce have been just as effective as ¾ and 1 ounce per tree. When this material is used, be sure the crystals are dry and not in a semi-solid state. They should also be finely divided, small enough to pass through a 10-mesh sieve or ordinary wire window screen. If large lumps are present, crush and pass them through a sieve.

Prepare the tree for application by removing the weeds, grass, leaves, etc. from about the base of the trunk. In other words, make a smooth clear space at soil level 6 to 12 inches wide about the base of the tree. Do not dig into the surface crust any more than is necessary. If the soil is stirred too much it will make numerous air spaces which are undesirable. In case a considerable amount of gum has exuded from the tree at or above the ground level it is best to remove the bulk of it. The gas does not readily penetrate large masses of gum.

In measuring out ¾ or 1 ounce of paradichlorobenzene use some vessel which when filled, holds the required amount; a short widemouth bottle or a tin or wooden pill box may answer the purpose. The paradichlorobenzene should be distributed evenly in a continuous narrow band an inch wide about the trunk. The bulk or center of the band should be 2 inches from the bark of the tree and no crystals should be closer than 1 inch from the tree. Injury may occur if the material is placed against the tree. On the other hand, if the material is placed 6 or more inches from the tree, it is much less effective in killing the borer. This is particularly true if the soil is wet.

After the application is made, place several shovelfuls of earth over the crystals and compact them into a cone-shaped pile with the back of the shovel or otherwise. The first shovelful of earth placed over the crystals should be finely divided and carefully placed on top of the ring of crystals in order that their location will not be disturbed.

Taking everything into consideration, the best time to apply paradichlorobenzene is immediately after all of the eggs have hatched. In the northern half of the state make the applications immediately after September 15 and in the southern half immediately after October 1. Applications made at this time will kill the old larvæ in the tree and the new crop. Applications made late in August or early in September will kill the larvæ in the tree but will not prevent the entrance of newly hatched larvæ. Larvæ hatching from eggs after the treatment is made will enter the tree above ground or where the surface of the soil meets the tree.

In the average season the crystals will not disappear completely before the ground freezes if the material is applied as late as September 15 to October 1. To obtain the greatest insurance against any possible injury from the gas to old peach trees it seems advisable to remove the dirt and crystals to the general soil level three or more weeks after the application is made.

Applications made in June and July kill most of the worms in the trees but such applications will not prevent the entrance of new larvæ appearing in August and September.

Two applications, one in May or June and one late in September or early in October will kill 90 to 100 per cent of the larvæ in the trees. To date we have seen no injury to 6-year-old trees (or older) which have received two applications in one season. As yet we have not made two treatments per season on younger trees.

The material should not be applied early in the spring if one expects immediate and effective results. The soil is too cold and wet. If an application is to be made early in the season the best time is May 1 to June 15.

Paradichlorobenzene will effectively kill peach-tree borers when the soil under the peach trees at a depth of 4 inches registers 60° F. or higher. Fairly satisfactory results have been obtained in soil at 55° F. At lower temperatures the larvæ are less active and the paradichlorobenzene vaporizes more slowly. This is particularly true at 50° F. or less, consequently the killing is much less effective in short exposures (2 to 3 weeks). Prolonged exposures (several months) at temperatures of 50° F. or less seem to be quite satisfactory in killing the larvæ and producing little or no injury.

Paradichlorobenzene is most effective as a fumigant in dry or semi-dry soil. If the crystals are placed about a tree when the soil is wet or saturated the material is quite ineffective as a fumigant in short exposures. This is probably due to the fact that all of the small air spaces are filled with water, consequently the gas, which is practically insoluble in water, is unable to penetrate the soil to any considerable distance in sufficient quantity to kill. The most effective results are obtained with paradichlorobenzene when the soil is comparatively dry.

Paradichlorobenzene can be obtained from several manufacturing firms. The price ranges from 20 to 30 cents a pound, depending upon the amount purchased. The total cost (including labor) of treating 6-year-old trees (or older) runs between 3 and 4 cents per tree.

Conclusions

The control of the peach-tree borer is still in the experimental stage, yet our results indicate that we can recommend the use of paradichlorobenzene on trees 6 years of age or older. We have also had satisfactory results with short exposures, 14 to 21 days, on trees 3 to 6 years of age.

Table 1

The influence of various preventive coatings and other substances on the peach-tree borer placed on and about 1 and 4-year-old peach trees; 100 eggs placed on the 4-year-old trees and 50 eggs on the 1-year-old trees; Wolpert Farm, 1920.

Experiment Number	TREATMENT	Age of Trees	Number of Trees	Larvæ per Tree				Injury
				Above Application	Under Application	Below Application	Total	
1	"Gipsy Moth Tree-banding Material," 8-inch band, 4 inches above and 4 inches below ground............	4	10	2.0	0.5	0.2	2.7	None to slight
2	"Gipsy Moth Tree-banding Material," 4-inch band above ground.........	4	5	1.8	0.0	0.8	2.6	None to slight
3	"Genasco Asphalt Putty," 8-inch band, 4 inches above and 4 inches below ground	4	10	0.4	6.3	1.4	8.1	Serious to dead
4	"Genasco Asphalt Putty," 4-inch band above ground	4	5	0.2	2.4	4.2	6.8	Slight
5	"Genasco Asphalt Fibre Coating," 8-inch band, 4 inches above and 4 inches below ground..............	4	10	0.2	4.8	0.8	5.8	None to slight
6	"Genasco Asphalt Fibre Coating," 4-inch band above ground and 1-inch trough	4	10	0.7	5.0	1.0	6.7	Considerable to serious
7	"Barber Brand Cold Repair Cement," 8-inch band, 4 inches above and 4 inches below ground..............	4	10	0.0	4.2	0.4	4.6	None to slight
8	"Barber Brand Cold Repair Cement," 4-inch band above ground and 1-inch trough	4	5	0.0	6.8	0.0	6.8	None to slight
9	"Gipsy Moth Tree-banding Material," 4-inch band, 1 inch above and 3 inches below ground..............	1	5	0.4	0.4	0.4	1.6	None
10	"Gipsy Moth Tree-banding Material," 4-inch band above ground.........	1	5	0.0	0.0	1.2	1.2	None
11	"Genasco Asphalt Putty," 4-inch band, 1 inch above and 3 inches below ground	1	5	0.0	0.8	2.6	3.4	None
12	"Genasco Asphalt Putty," 4-inch band above ground	1	5	0.0	1.0	2.4	3.4	None
13	"Genasco Asphalt Fibre Coating," 4-inch band, 1 inch above and 3 inches below ground	1	5	0.4	0.0	2.8	3.2	None

Table 1—Continued

The influence of various preventive coatings and other substances on the peach-tree borer placed on and about 1 and 4-year-old peach trees; 100 eggs placed on the 4-year-old trees and 50 eggs on the 1-year-old trees; Wolpert Farm, 1920.

Experiment Number	TREATMENT	Age of Trees	Number of Trees	Larvæ per Tree				Injury
				Above Application	Under Application	Below Application	Total	
14	"Genasco Asphalt Fibre Coating," 4-inch band above ground and 1-inch trough	1	5	0.4	0.0	1.2	1.6	None to sligh
15	"Barber Brand Cold Repair Cement," 4-inch band, 1 inch above and 3 inches below ground	1	5	0.0	0.2	1.2	1.4	None to slight
16	"Barber Brand Cold Repair Cement," 4-inch band above ground and 1-inch trough	1	5	0.0	0.0	1.4	1.4	None to slight
17	"Borowax," 2-inch trough about tree	1	5	0.2	0.0	0.6	0.8	Slight
18	"Borowax," 2-inch trough about tree	4	5	1.6	2.2	0.4	4.2	Serious to dead
19	"Borowax," plus sawdust in trough about tree	1	5	0.2	0.4	0.2	0.8	None to slight
20	"Borowax," plus sawdust in trough about tree	4	5	4.1	4.8	1.2	10.1	Slight
21	"Borowax," plus sand in trough about tree	4	5	3.8	1.8	0.2	5.8	Slight to serious
22	Pine-tar, 2-inch trough about tree	4	5	2.0	2.2	1.4	5.6	None
23	Pine-tar plus sawdust in trough about tree	1	5	0.0	0.0	2.0	2.0	None
24	Pine-tar plus sawdust in trough about tree	4	5	2.2	5.2	3.0	10.4	None
25	Pine-tar plus sand in trough about tree	4	5	2.2	2.0	3.0	7.2	None
26	Check	4	10	....	....	....	6.6	None
27	Check	1	5	....	....	....	2.6	None

CRANBERRY INVESTIGATIONS

Charles S. Beckwith

The cranberry investigations were materially enlarged during 1920. The plant-food study was extended to cover a more exact test of the effect of fertilizer treatments on deep mud soil, the soil acidity and the water-table study were continued and two new studies, the effect of submerging on the cranberry plant and the cranberry weed study were started. In addition to the above some notes were made on the practical control of cranberry girdler. The data collected are presented herewith under separate headings.

Plant-Food Investigation

The study to find the optimum amount of nitrogen which should be applied to Savannah soil and to show the effect of drawing the needed nitrogen from a mixture of mineral and organic sources was started last year and continued the present year. The treatments repeated in 1920, and the current year's crop are given in table 1.

Table 1

Results of Nitrogen Experiments on Savannah Soil, 1920; Variety, Early Black

Plot	Treatment per Acre	Nitrogen Applied per Acre	Yield per Acre	Increase Over Checks
		lbs.	lbs.	per cent
F-SB-N- 1	Nothing	....	3680	....
F-SB-N- 2	140 lbs. sodium nitrate	20	6020	80
F-SB-N- 3	Nothing	....	3020	....
F-SB-N- 4	70 lbs. sodium nitrate; 85 lbs. dried blood	20	4920	54
F-SB-N- 5	Nothing	....	3400	....
F-SB-N- 6	170 lbs. dried blood	20	4320	12
F-SB-N- 7	Nothing	....	4300	....
F-SB-N- 8	210 lbs. sodium nitrate	30	6000	58
F-SB-N- 9	Nothing	....	3300	....
F-SB-N-10	105 lbs. sodium nitrate; 127½ lbs. dried blood	30	4850	84
F-SB-N-11	Nothing	....	1980	....
F-SB-N-12	255 lbs. dried blood	30	2680	52
F-SB-N-13	Nothing	....	1540	....

The results last year showed that 30 pounds of nitrogen to the acre gave a better yield than 20 pounds of nitrogen and that the application of a mixture of mineral and organic nitrogen did not give a larger crop than did an application of the same amount of nitrogen drawn from nitrate of soda alone. This year's results show that 30 pounds of nitrogen drawn from nitrate of soda is too great for annual treatments and that 20 pounds is nearer the correct amount for a large crop. The change is due to the fact that some residual effect of last year's application added to this year's treatment makes the larger application too great although it is evident that if only one treatment were made, 30 pounds would be quite satisfactory. The nitrogen from dried blood does not appear to be as available to the cranberry plant as nitrogen from nitrate of soda, an application of 30 pounds of nitrogen from the former not giving an increase as great as 20 pounds of nitrogen drawn from the latter. There seems to be no particular advantage to be gained in mixing the two carriers of nitrogen, as the results show that after conceding plot 8 has been over-fertilized, the increase in yield is midway between the increase when each material is used separately. In order to check the results, this study will be carried on at least one more year.

A second study was designed tc show the optimum amount of a tentative formula for a mixed fertilizer for Savannah soil. The formula was adopted after a careful study of 6 years' records on fertilizer plots, and is as follows:

Sodium nitrate	75 pounds
Dried blood	75 pounds
Rock phosphate	300 pounds
Sulfate of potash	50 pounds

The treatments made this year did not include the acid phosphate that was used last year and plot 8 did not receive anything, as the vine growth on this plot was already excessive and any additional treatment would result in certain injury. Otherwise, the treatments were the same as last year. The treatments and results are given in table 2.

Table 2

Results of Tests with a Mixed Fertilizer on Savannah Soil, 1920; Variety, Early Black

Plot	Treatment per Acre	Yield per Acre	Increase Over Checks
		lbs.	per cent
SB-F-C-1	Nothing	1540	....
SB-F-C-2	264 lbs. mixture	2520	61½
SB-F-C-3	Nothing	1580	....
SB-F-C-4	528 lbs. mixture	2620	68
SB-F-C-5	Nothing	1540	....
SB-F-C-6	792 lbs. mixture	3680	82
SB-F-C-7	Nothing	2500	....
SB-F-C-8	1056 lbs. mixture (1919 only)	2980	45½
SB-F-C-9	Nothing	1600	....

The improvement in the treated plots is more marked than it was last year. The plot receiving 792 pounds of the mixture seems to be in excellent condition and able to continue to produce large crops. This study is to be continued.

The next study was designed to show the optimum amount of phosphoric acid that should be applied to Savannah mud and iron-ore bottom. This is a continuation of the study started last year. The treatments and the yields are given in table 3.

Table 3

Results of Phosphate Tests, 1920; Variety, Early Black

Plot	Treatment per acre	P_2O_5 per acre	Yield					
			Savannah SB-F-P		Mud MB-F-P		Iron Ore IB-F-P	
			Per Acre	Gain	Per Acre	Gain	Per Acre	Gain
		lbs.	lbs.	per cent	lbs.	per cent	lbs.	per cent
1	Nothing		2310		5280		3080	
2	75 lbs. phosphate rock....	20	2210	12	7480	13	2200	9
3	Nothing		1470		7920		1760	
4	150 lbs. phosphate rock....	40	2240	1	6060	19	3300	99
5	Nothing		2960		7040		1960	
6	225 lbs. phosphate rock....	60	3960	40	6820	3	2640	28
7	Nothing		4540		6160		2740	
8	300 lbs phosphate rock....	80	2480	79	7260	10	3300	13
9	Nothing		2600		7040		3080	
10	150 lbs. phosphate rock....	40	2320	6	7040	14	4040	6
11	Nothing		2460		5280		4180	
12	150 lbs. soft phosphate rock	40	2220	2	4840	10	4840	14
13	Nothing		2060		3430		4180	
14	250 lbs. acid phosphate....	40	2160	19	4620	—3	4840	13
15	Nothing		1560		4770		4400	

The results are rather erratic but no plot shows damage due to excessive phosphoric acid. This study is to be continued.

Investigation was made to show the value of barium phosphate as a cranberry plant-food. This study is in its second year, the treatments were made last year and the residual effect recorded this year.

Table 4

Results of Tests with Barium Phosphate; Variety, Early Black

Plot	Treatment per acre	P_2O_5	Yield					
			Savannah		Mud		Iron Ore	
			Per Acre	Gain	Per Acre	Gain	Per Acre	Gain
		lbs.	lbs.	per cent	lbs.	per cent	lbs.	per cent
1	Nothing		2060		3430		4400	
2	250 lbs. acid phosphate	40	2160	19	4620	—3	3960	6
3	Nothing		1560		4770		3080	
4	150 lbs. phosphate rock and 7 per cent barium sulfide	40	2240	47	5280	—11	1760	14
5	Nothing		1540		7040		1540	
6	150 lbs. soft phosphate rock and 7 per cent barium sulfide	40	2600	49	4860	—35	780	62
7	Nothing		1940		7920		2640	
8	150 lbs. barium phosphate	40	1980	8	5180	—37	3740	13
9	Nothing		1720		8580		6020	

The results of last year's tests taken together with this year's do not show benefit gained through the use of barium phosphate as such. The adding of 7 per cent barium sulfide to the ground phosphate rock seems to make it a better plant-food.

Calcium cyanamide was tested as a cranberry fertilizer in 1919. The material used tested 18.16 per cent nitrogen. No new application was made in 1920, but the residual effect of the treatment is given in table 5.

Table 5

Results of Tests with Calcium Cyanamide on Savannah Soil; Variety, Late Howe

Plot	Treatment per acre	Yield per acre	Increase Over Checks
1	Nothing	5653	
2	120 lbs. calcium cyanamide	5653	28
3	Nothing	3147	
4	120 lbs. calcium cyanamide, 250 pounds acid phosphate, 220 pounds sulfate of potash	4720	44
5	Nothing	3413	
6	120 lbs. calcium cyanamide, 2,000 pounds ground limestone	5113	20
7	Nothing	5113	
8	120 pounds calcium cyanamide, 250 lbs. acid phosphate, 220 lbs. sulfate of potash, 2,000 lbs. ground limestone	5387	5
9	Nothing	5113	

The residual effect of the calcium cyanamide seems to be more pronounced than the effect during the year of application. However, the gain through its use does not seem to be as pronounced as with an equivalent amount of nitrogen from nitrate of soda.

A qualitative study of plant-foods has been made on Savannah bottom. The plots of this series were first treated in 1913. The treatments were made annually from 1913 to 1915, inclusive. A considerable increase in vine growth on treated plots made a cessation of treatments necessary in 1916 and 1917. Some pruning was done and reported in 1916. In 1918 the nitrogen and phosphoric acid treatments were added in one-half their former amounts but no potash at all was used. In addition each plot receiving sulfate received a treatment of ground limestone equivalent to 1,000 pounds to the acre. In 1919 an infestation of blossom worms cut the crops seriously on all fertilized plots, but left the untreated plots practically free from injury. This made the crop record of 1919 valueless as a plant-food study and such record was not made. The crop record of 1920 is reported in table 6, together with the treatments the plots received in 1913.

Table 6

Series A. The Effect of Plant-Food Applications on Savannah Bottom, 1920

Plot Number	TREATMENT PER ACRE	Yield per acre	Gain over check	REMARKS
		lbs.	per cent	
1	280 lbs. nitrate of soda	7630	1	
2	Nothing	7580		
3	200 lbs. ammonium sulfate	5160	—21	This loss is due to actual injury by the treatment.
4	Nothing	4910		
5	400 lbs. dried blood	5440	10	
6	Nothing	4970		
7	600 lbs. cottonseed meal	4520	—9	
8	Nothing	4880		
9	280 lbs. nitrate of soda, 500 lbs. acid phosphate, 200 lbs. muriate of potash	6740	47	
10	Nothing	4300		
11	200 lbs. ammonium sulfate, 500 lbs. acid phosphate, 200 lbs. muriate of potash	6730	53	
12	Nothing	4480		
13	400 lbs. dried blood, 500 lbs. acid phosphate, 200 lbs. muriate of potash	4720	—4	
14	Nothing	5370		
15	600 lbs. cottonseed meal, 500 lbs. acid phosphate, 200 lbs. muriate of potash	6010	15	
16	Nothing	5060		
17	500 lbs. acid phosphate	5500	14	
18	Nothing	4560		
19	500 lbs. basic slag	4760		
20	Nothing	3910		
21	300 lbs. rock phosphate	5360	32	
22	Nothing	4200		
23	300 lbs. steamed bone	4520	8	
24	Nothing	4740		
25	600 lbs. bone meal, 200 lbs. ammonium sulfate, 200 lbs. muriate of potash	2860	—38	This plot has serious girdler infestations as an indirect result of treatment.
26	Nothing	4490		
27	500 lbs. basic slag, 280 lbs. nitrate of soda, 200 lbs. muriate of potash	5810	23	
28	Nothing	4930		
29	300 lbs. phosphate rock, 200 lbs. ammonium sulfate, 200 lbs. muriate of potash	1710	—57	This plot has serious girdler injury as an indirect result of treatment.
30	Nothing	5660		

Table 6—Continued

Plot Number	TREATMENT PER ACRE	Yield per acre	Gain over check	REMARKS
31	300 lbs. steamed bone, 200 lbs. ammonium sulfate, 200 lbs. muriate of potash	5620	—5	This plot has serious girdler injury as an indirect result of treatment.
32	Nothing	6120		
33	200 lbs. muriate of potash	5550	39	
34	Nothing	1820		
35	200 lbs. sulfate of potash	3760	39	Compared with 36 only.
36	Nothing	2700		
37	840 lbs. kainit	2360	—2	
38	Nothing	2140		
39	200 lbs. sulfate of potash, 200 lbs. ammonium sulfate, 500 lbs. acid phosphate	3260	54	
40	Nothing	2140		
41	840 lbs. kainit, 200 lbs. ammonium sulfate, 500 lbs. acid phosphate	3700	64	
42	Nothing	2360		

It is evident from the results that the plant-food applications are about used up especially where nitrogen alone has been used. The phosphates, especially rock phosphate, are more lasting, but even with them the gain is small. The potash plots with the exception of the one receiving kainit shows surprising gains over checks this year. Plot 3, receiving ammonium sulfate only, suffered direct injury from the treatment. Plots 25, 29 and 31 received their injury from cranberry girdler which may be considered as a secondary result of the plant-food treatment.

An additional study was started this year to show the effect of plant-food applications on mud-bottom cranberry bogs. The practice of treating such land is little understood outside the information gained by our own previous experiments reported in the Annual Report for 1916 (p. 329). Particular forms of plant-foods seem to be adapted to mud-bottom conditions but we have no information that would indicate the actual or relative amount of each plant-food that should be used. The present study was designed to furnish data on the latter point.

The plant-foods applied were in that form which seemed best suited to the conditions. The nitrogen was derived from a mixture made up by mixing an equal quantity of nitrate of soda and tankage. It had a nitrogen content of 11.5 per cent. The phosphate was derived from a mixture made up by mixing an equal quantity of acid phosphate and rock phosphate. The rock phosphate becomes available slowly and is a very desirable source of phosphoric acid. Acid phosphate becomes available quickly and serves the plant during the period before the time the rock phosphate becomes available. The mixture analyzes 22½ per cent P_2O_5. The potash mixture is made up entirely of muriate of potash having an analysis of 49 per cent K_2O.

The study was planned on a Howe bog 4 years old. Because of the level land and the regular drainage the vines were very even. There are 40 plots in all, 20 in the series with 20 duplicates. The treatment is given in pounds of nitrogen, phosphoric acid, and potash per acre, and the yield is given in pounds per acre.

On the duplicate series, the writer had an opportunity to collect additional information. The size of the berries is given in the number of berries to an inspector's cup, an average of three countings. The percentage of rot was taken by carefully sorting out by hand all the good berries. The growth of vines is given as the average annual growth of 75 uprights measured in various parts of the plots. As far as practicable, uprights bearing berries this year and terminating in a fruit bud for next year were measured. No measurements of runner growth were attempted.

The data are given in table 7.

Table 7

Results of Tests in Modified Triangle Series of Fertilizer Plots, on Mud Bottom

Plot No.	Treatment per Acre			Yield per Acre	Gain	Size of Berries Number to cup	Rot	Growth of Vines
	N	P_2O_5	K_2O					
	lbs.	lbs.	lbs.	lbs.	per cent		per cent	inches
1	15	0	0	350	0	....	....	....
2	10	30	0	540	54	....	....	....
3	0	0	0	350	—	....	....	....
4	5	60	0	360	3	....	....	....
5	0	90	0	390	13	....	....	....
6	0	60	5	380	660	....	....	....
7	0	30	10	380	660	....	....	....
8	0	0	0	50	—	....	....	....
9	0	0	15	50	0	....	....	....
10	5	0	10	130	160	....	....	....
11	10	0	5	140	—30	....	....	....
12	15	90	15	320	60	....	....	....
13	0	0	0	200	—	....	....	....
14	15	90	10	340	70	....	....	....
15	10	90	15	300	50	....	....	....
16	15	60	15	600	700	....	....	....
17	10	60	10	190	137	....	....	....
18	0	0	0	80	—	....	....	....
19	10	30	10	220	175	....	....	....
20	5	60	5	230	187	....	....	....
21	5	60	5	550	—18	73	18	2.45
22	10	30	10	870	30	76	29	2.59
23	0	0	0	670	—	94	17	2.25
24	10	60	10	560	—16	86	6	2.70
25	15	60	15	340	—50	77	3	2.78
26	10	90	15	290	—20	71	5	2.39
27	15	90	10	370	3	74	4	2.50
28	0	0	0	360	—	84	4	2.44
29	15	90	15	380	60	72	3	3.02
30	10	0	5	180	—50	80	6	3.08
31	5	0	10	195	—20	88	3	2.76
32	0	0	15	260	1	93	4	2.46
33	0	0	0	255	—	97	4	2.41
34	0	30	10	395	56	79	3	2.42
35	0	60	5	675	160	77	5	2.42
36	0	90	0	580	205	73	3	2.39
37	5	60	0	410	101	75	4	2.60
38	0	0	0	190	—	91	5	2.37
39	10	30	0	455	140	75	3	2.82
40	15	0	0	260	37	80	4	2.67

The crop of 1920 is the first one to be picked from this bog and therefore is rather small with large berries. The erratic yields of the check plots reduce the value of the yield records of the year, especially that of plot 23. However, it appears from the size of the berries, the growth of the vines and the general crop that phosphoric acid is the limiting factor on mud bottoms of this type.

The Soil Acidity Study

The soil acidity study has been carried on now through three successive years according to the plan adopted in 1918. It is not necessary to explain the plan to those who have been following the work but the general outline is worth repeating.

The study was planned after it had been determined that most cranberry bogs are too acid and that reduction of the acidity by means of lime applications gave an increased crop. The study was planned to determine the optimum degree of soil acidity for the cranberry bog and the best method of obtaining it.

The study comprehends a set of 10 plots each 1 rod wide and 8 rods long with treatments in 1918 as follows:

Treatment Per Acre on Soil Acidity Plots

1 Nothing
2 1000 lbs. non-magnesium limestone
3 1000 lbs. magnesium limestone
4 Nothing
5 2000 lbs. non-magnesium limestone
6 2000 lbs. magnesium limestone
7 Nothing
8 4000 lbs. non-magnesium limestone
9 4000 lbs. magnesium limestone
10 Nothing

In 1919 a space of 2 rods on one end of the plots was left untreated while the remaining 6 rods received the same treatment that they received in 1919. In 1920 an additional 2 rods was left untreated and the remaining 4 rods received the treatment at the same rate per acre as they received in 1918 and 1919. At the close of 1920 we have plots which have received a total treatment of as little as 1,000 pounds of ground limestone, plots which have around a total of 12,000 pounds of ground limestone to the acre, and some others receiving treatments of intermediate amounts. The study was in triplicate, one set of plots being on Savannah bottom, one set on iron-ore bottom, and one on mud bottom.

Table 8

Soil Acidity Treatment and Yield per Acre of Cranberries on Savannah Land; Season, 1920

Plot	TREATMENT PER ACRE			Yield 1920 per acre	Gain over check
	1918	1919	1920		
				lbs.	per cent
1	Nothing	Nothing	Nothing	3960	..
2	1000 lbs. H. C. Limestone	Nothing	Nothing	5560	41
3	1000 lbs. M. Limestone	Nothing	Nothing	5600	21
4	Nothing	Nothing	Nothing	4680	..
5	2000 lbs. H. C. Limestone	Nothing	Nothing	5120	9
6	2000 lbs. M. Limestone	Nothing	Nothing	5040	52
7	Nothing	Nothing	Nothing	3320	..
8	4000 lbs. H. C. Limestone	Nothing	Nothing	5960	80
9	4000 lbs. M. Limestone	Nothing	Nothing	4800	8
10	Nothing	Nothing	Nothing	4440	..
1A	Nothing	Nothing	Nothing	4800	..
2A	1000 lbs. H. C. Limestone	1000 lbs. H. C. Limestone	Nothing	6080	27
3A	1000 lbs. M. Limestone	1000 lbs. M. Limestone	Nothing	5760	36
4A	Nothing	Nothing	Nothing	4240	..
5A	2000 lbs. H. C. Limestone	2000 lbs. H. C. Limestone	Nothing	3200	—23
6A	2000 lbs. M. Limestone	2000 lbs. M. Limestone	Nothing	5120	62
7A	Nothing	Nothing	Nothing	3160	..
8A	4000 lbs. H. C. Limestone	4000 lbs. H. C. Limestone	Nothing	4440	36
9A	4000 lbs. M. Limestone	4000 lbs. M. Limestone	Nothing	5560	39
10A	Nothing	Nothing	Nothing	4720	..
1B	Nothing	Nothing	Nothing	1800	..
2B	1000 lbs. H. C. Limestone	1000 lbs. H. C. Limestone	1000 lbs. H. C. Limestone	7780	320
3B	1000 lbs. M. Limestone	1000 lbs. M. Limestone	1000 lbs. M. Limestone	6260	66
4B	Nothing	Nothing	Nothing	3780	..
5B	2000 lbs. H. C. Limestone	2000 lbs. H. C. Limestone	2000 lbs. H. C. Limestone	5120	35
6B	2000 lbs. M. Limestone	2000 lbs. M. Limestone	2000 lbs. M. Limestone	4080	9
7B	Nothing	Nothing	Nothing	3760	..
8B	4000 lbs. H. C. Limestone	4000 lbs. H. C. Limestone	4000 lbs. H. C. Limestone	5480	46
9B	4000 lbs. M. Limestone	4000 lbs. M. Limestone	4000 lbs. M. Limestone	5420	—4
10B	Nothing	Nothing	Nothing	5620	..

H. C. Limestone = High-calcium limestone analyzing 98 per cent $CaCO_3$.
M. Limestone = Magnesium limestone analyzing about 40 per cent $MgCO_3$ and 52 per cent $CaCO_3$.

Table 9

Soil Acidity Treatment and Yield per Acre of Cranberries on Deep Mud Bottom; Season, 1920

Plot	TREATMENT PER ACRE			Yield 1920	Gain over check
	1918	1919	1920		
				lbs.	per cent
1	Nothing	Nothing	Nothing	4840	..
2	1000 lbs. H. C. Limestone	Nothing	Nothing	6520	35
3	1000 lbs. M. Limestone	Nothing	Nothing	6520	17
4	Nothing	Nothing	Nothing	5560	..
5	2000 lbs. H. C. Limestone	Nothing	Nothing	7040	26
6	2000 lbs. M. Limestone	Nothing	Nothing	6520	—7
7	Nothing	Nothing	Nothing	7040	..
8	4000 lbs. H. C. Limestone	Nothing	Nothing	6160	—12
9	4000 lbs. M. Limestone	Nothing	Nothing	7480	0
10	Nothing	Nothing	Nothing	7480	..
1A	Nothing	Nothing	Nothing	3960	..
2A	1000 lbs. H. C. Limestone	1000 lbs. H. C. Limestone	Nothing	5280	34
3A	1000 lbs. M. Limestone	1000 lbs. M. Limestone	Nothing	5440	—2
4A	Nothing	Nothing	Nothing	5520	..
5A	2000 lbs. H. C. Limestone	2000 lbs. H. C. Limestone	Nothing	6320	14
6A	2000 lbs. M. Limestone	2000 lbs. M. Limestone	Nothing	6520	0
7A	Nothing	Nothing	Nothing	6520	..
8A	4000 lbs. H. C. Limestone	4000 lbs. H. C. Limestone	Nothing	5280	—19
9A	4000 lbs. M. Limestone	4000 lbs. M. Limestone	Nothing	7040	15
10A	Nothing	Nothing	Nothing	6160	..
1B	Nothing	Nothing	Nothing	5980	..
2B	1000 lbs. H. C. Limestone	1000 lbs. H. C. Limestone	1000 lbs. H. C. Limestone	6260	5
3B	1000 lbs. M. Limestone	1000 lbs. M. Limestone	1000 lbs. M. Limestone	6400	—12
4B	Nothing	Nothing	Nothing	7260	..
5B	2000 lbs. H. C. Limestone	2000 lbs. H. C. Limestone	2000 lbs. H. C. Limestone	6260	—14
6B	2000 lbs. M. Limestone	2000 lbs. M. Limestone	2000 lbs. M. Limestone	5280	—4
7B	Nothing	Nothing	Nothing	5500	..
8B	4000 lbs. H. C. Limestone	4000 lbs. H. C. Limestone	4000 lbs. H. C. Limestone	6160	12
9B	4000 lbs. M. Limestone	4000 lbs. M. Limestone	4000 lbs. M. Limestone	6380	—11
10B	Nothing	Nothing	Nothing	7040	..

Table 10

Soil Acidity Treatment and Yield per Acre of Cranberries on Iron-Ore Bottom; Season, 1920

Plot	TREATMENT PER ACRE 1918	1919	1920	Yield 1920	Gain over check
				lbs.	per cent
2	1000 lbs. H. C. Limestone	Nothing	Nothing	6720	—6
3	1000 lbs. M. Limestone	Nothing	Nothing	7960	12
4	Nothing	Nothing	Nothing	7120	..
5	2000 lbs. H. C. Limestone	Nothing	Nothing	10040	41
6	2000 lbs. M. Limestone	Nothing	Nothing	11160	57
7	Nothing	Nothing	Nothing	7120	..
8	4000 lbs. H. C. Limestone	Nothing	Nothing	7280	2
9	4000 lbs. M. Limestone	Nothing	Nothing	7256	2
2A	1000 lbs. H. C. Limestone	1000 lbs. H. C. Limestone	Nothing	7528	23
3A	1000 lbs. M. Limestone	1000 lbs. M. Limestone	Nothing	5040	18
4A	Nothing	Nothing	Nothing	6120	..
5A	2000 lbs. H. C. Limestone	2000 lbs. H. C. Limestone	Nothing	6840	12
6A	2000 lbs. M. Limestone	2000 lbs. M. Limestone	Nothing	6360	4
7A	Nothing	Nothing	Nothing	6120	..
8A	4000 lbs. H. C. Limestone	4000 lbs. H. C. Limestone	Nothing	8560	40
9A	4000 lbs. M. Limestone	4000 lbs. M. Limestone	Nothing	4000	—35
2B	1000 lbs. H. C. Limestone	1000 lbs. H. C. Limestone	1000 lbs. H. C. Limestone	4620	28
3B	1000 lbs. M. Limestone	1000 lbs. M. Limestone	1000 lbs. M. Limestone	4280	19
4B	Nothing	Nothing	Nothing	3600	..
5B	2000 lbs. H. C. Limestone	2000 lbs. H. C. Limestone	2000 lbs. H. C. Limestone	3540	—2
6B	2000 lbs. M. Limestone	2000 lbs. M. Limestone	2000 lbs. M. Limestone	2920	—19
7B	Nothing	Nothing	Nothing	3600	..
8B	4000 lbs. H. C. Limestone	4000 lbs. H. C. Limestone	4000 lbs. H. C. Limestone	3260	—9
9B	4000 lbs. M. Limestone	4000 lbs. M. Limestone	4000 lbs. M. Limestone	3480	—3

A difference in yield between the limed and the unlimed plots is apparent for the first time in the 1920 crop. The results on the Savannah bottom are most striking. On the plots which received treatment in 1918 only, every treated plot shows an increaseed yield over the untreated plot, the greatest increase being in the case of plot 8, which received high-calcium limestone at the rate of 4,000 pounds to the acre. In the series receiving treatments in 1918 and 1919 the same beneficial effect is present, but the greater yields are shown with the smaller amounts of limestone. The series receiving limestone treatments annually show a slight general increase, the larger increases showing on the plots receiving the smaller amounts of limestone. These facts bear out the conclusion held by Waksman that the addition of limestone to cranberry soil makes a medium in the soil favorable to the development of microflora of the soil and bacteria capable of fixing atmospheric nitrogen. The increase in crop yield may be due directly to the nitrogen fixed by these bacteria. The time necessary for such a favorable turn is evidently 3 years on Savannah soil.

The possible development of bacteria makes the hydrogen-ion concentration of the soil an important and interesting measurable quantity in following the growth of the bacteria, and for this reason the hydrogen-ion concentration of each plot was taken. It is given in table 11.

Table 11

Hydrogen-ion Concentration of Savannah Land Plots Receiving Ground Limestone Treatments

Plot	Treatment per Acre	1918 only	1918 and 1919	1918, 1919 and 1920
		pH	pH	pH
1	Nothing	4.05	4.05	4.05
2	1000 lbs. non-magnesium limestone	4.25	4.25	4.60
3	1000 lbs. magnesium limestone	4.60	5.00	5.40
4	Nothing	4.05	4.05	4.05
5	2000 lbs. non-magnesium limestone	4.40	5.60	4.60
6	2000 lbs. magnesium limestone	4.05	5.40	5.75
7	Nothing	4.05	4.05	4.05
8	4000 lbs. non-magnesium limestone	4.49	4.80	5.90
9	4000 lbs. magnesium limestone	4.60	6.30	5.95
10	Nothing	4.05	4.10	4.05

The best yields this year occurred on the plots where the hydrogen-ion concentration of the soil was about 4.4 to 4.6. The results from the year's crop is not conclusive, however, and further study is being made of the soil and its qualities.

On mud bottom the average yield of the treated plots is higher than the average of the check plots, but the increase is not as clear as it is on Savannah bottom. It would seem that the bacterial activity which is going on on the Savannah plots is somewhat slower on mud bottom, and for this reason the records do not show decided results.

The results on the iron-ore bottom show slightly greater changes than those on mud bottom, so we are forced to assume that the lack of results is due to slow development on the mud and iron-ore soils.

The Effect of Flooding on the Cranberry Plant

The flooding experiments herein described were carried out by Steich Wakabayashi, working under the direction of Dr. J. W. Shive, plant physiologist of the Experiment Station. The work was carried on under the immediate supervision of the writer at Whitesbog during the summer of 1920.

Previous work has shown that the cranberry girdler, the army worm and the blossom worm can be killed by submerging the infested bog for various periods of time during some susceptible stage of the insect's life history. We have little definite data to show the effect of such submergence on the cranberry plant. Franklin,* working at the Massachusetts Cranberry Sub-Station, has shown that submergence in spring for 48 hours was fatal to fruit buds under certain weather conditions.

The present experiments have been undertaken to throw some light on the relation between the duration of the flooding period and the plant activities, the weather conditions during the period of flooding and the plant activities, flooding at various stages of the plant development and plant activities, and finally, flooding at various stages of the plant development and the keeping quality of the fruit.

Because of the difficulty of growing to maturity cranberry plants under absolutely controlled conditions, a section of the bog already in bearing was selected for the flooding experiments. Each plot was enclosed within a box 6 feet square, the sides of which were embedded firmly in the ground, and high enough to allow complete submergence of the plants. Water was supplied through a hose siphon from a reservoir nearby. Flooding and draining were commenced early in the evening so that no plant was exposed to the sun in a partly submerged condition.

The treatments and results are shown in table 12.

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*Thirty-second Ann. Rept., Cape Cod Cranberry Growers' Association, 1919-1920, p. 11-13 and 19-30.

Table 12

Results of Flooding Experiment

Plot	Treatment (Length of Time Submerged)	Time Submerged	Weather During Submergence	Effect on Plant
A	24 hrs.	July 28-29	July 28, fair July 29, fair July 30, fair	No change
B	48 hrs.	July 28-30	July 28, fair July 31, fair	No change
C	48 hrs. repeated every 10 days	July 30—Aug. 2 Aug. 10-12 Aug. 20-22 Aug. 31—Sept. 2 Sept. 12-14	Fair—rainy Fair Fair Fair Fair	Ripening of berries retarded, leaves became deeper green: some berries floated away
D	48 hrs. (shaded)	Aug. 5-7	Aug. 6, cloudy 7, fair 8, fair 9, fair 10, cloudy	A few of the higher tips turned brown and in 10 to 15 days they defoliated for ¼ to ½ inch
E	6 days	Aug. 7-13	Aug. 8, fair 9, fair 10, cloudy 11, fair 12, fair 13, fair 14, cloudy 15, cloudy	Leaves showed deeper green; ripening was retarded; some berries floated away
F	4 days	Aug. 10-14	Aug. 10, cloudy 11, fair 12, fair 13, fair 14, cloudy 15, cloudy	Similar to E, but to a lesser extent
G	48 hrs. (with shade)	Aug. 14-16	Aug. 15, cloudy 16, fair 17, cloudy 18, cloudy	Showed no change as did F
H	Shaded 90 hrs. without flooding	Aug. 14-18	Aug. 15, cloudy 16, fair 17, cloudy 18, cloudy	Showed no change in vines
I	Flooded 7 days	Aug. 23-30	Aug. 24, cloudy 25, cloudy 26, fair 27, fair 28, cloudy 29, cloudy 30, fair 31, fair	Ripening retarded, leaves deep green, 4 per cent berries floated away

Table 12—Continued

Plot	Treatment (Length of Time Submerged)	Time Submerged	Weather During Submergence	Effect on Plant
J	Flooded 7 days	Sept. 2-9	Sept. 2, fair 3, fair 4, fair 5, fair 6, cloudy 7, cloudy 8, fair 9, cloudy 10, fair	Ripening retarded, leaves deeper green, 2 per cent berries floated away

From these data it is clear that in small plots when flooded to a depth of 1 foot and the water removed promptly: (1) there is no apparent injury to the vines, (2) maturation is retarded, (3) if flooded early in the season cloudy weather during the flooding period may cause the tips to die back, (4) the number of diseased berries increases, especially when flooded late in the season, (5) some berries, probably less than 5 per cent, break loose from the vines.

In order to show the effect of ripening on the vines or in the storehouse, an additional plot was flooded 5 days. One-fourth of the berries were picked immediately after drying, another fourth were picked 2 days later, another 2 weeks later, and the last 1 month later. The berries were sorted on November 26, and the results were as given in table 13.

Table 13

Effect of Flooding on the Keeping Quality of Cranberries

Berries Picked	Berries Sorted	Good	Rotted	Proportion of Rot
		lbs.	lbs.	per cent
9/22	11/26	683	46	6
9/24	11/26	350	29	7
10/6	11/26	379	35	9
10/23	11/26	374	16	4

The results show that the percentage of rot and the time of picking after flooding of nearly matured berries have little correlation in this trial, though more trials are needed to furnish a definite conclusion.

The general result of the flooding in small plots seemed to indicate that with reasonable care a small bog could be flooded before harvest without great injury. To test this out a small Centennial bog was flooded for 7 days. After removing the water, counts were made on the berries taken from various parts of the bog. The results are stated in table 14.

Table 14

Effect of Flooding on Centennial Berries

Plot	Location	Condition	Number	Per cent
1	High ground	Sound	313	84
		Rotten	3	1
		Reflow injury	58	15
2	Medium ground	Sound	141	77
		Rotten	4	2
		Reflow injury	39	21
3	Low ground	Sound	123	64
		Rotten	7	4
		Reflow injury	60	31

The enormous injury on the flooded bog in contrast with the result on small plots makes the problem difficult to explain. Further investigation is needed on this point.

A large Howe bog badly infested with girdler was flooded for 3 to 4 days after picking but one-eighth of the crop. During November the entire lot was sorted and the data available are given in table 15.

Table 15

Effect of Flooding on Bog of Howe Cranberries

Crop picked before flooding	540 bbl.
Crop picked after flooding	3960 bbl.

	Picked before flooding—	Picked after flooding—
Sound	88 per cent	68 per cent
Soft	7 per cent	15 per cent
Spotted	5 per cent	17 per cent
Total unsalable	12 per cent	32 per cent

Value of berries	$10 per bbl.
Cost of packing, shipping and selling	3 per bbl.
Net	$7 per bbl.

Difference in unsalable Berries, 20 per cent

20 per cent of 3960 is 792 bbl., at $7.00 = $5544, loss on crop.

Cost of sorting first picking	$0.42 per bbl.
Cost of sorting last picking	1.25 per bbl.
Difference	$0.83 per bbl.

3960 — 792 = 3168 × $0.83 = $2629.44, extra cost of sorting.

Cost of treatment without allowing for the loss on the berries shipped is $8,173.44.

From the present knowledge, we can see that it is highly dangerous to flow bogs while the crop is still on the vines. When it is necessary to flood for cranberry girdler it seems much more economical to harvest the immature crop during September and flood the bog immediately rather than flood with the berries on it.

Cranberry Weed Study

Weeds are known to bear a more important relation to cranberry culture in New Jersey than they do in other cranberry-producing states. The fact that New Jersey bogs usually are made without a sand covering over the muck accounts for the invasion of much of the foreign growth. New Jersey conditions make the use of sand impracticable, and other methods of controlling weeds should be devised.

An effective start was made this year when Elba E. Watson, working at the cranberry substation, listed and described 40 species of the more important weeds common on New Jersey bogs. A short account of the habitat of each plant is included with its description, and a specimen of each species is preserved in the herbarium of th cranberry substation. Practical control measures are being worke out, now that we have a knowledge of their habits of growth an reproduction.

SEWAGE INVESTIGATIONS

The studies of the present year have been devoted to determining the identity of certain plants and animals found in the sprinkling sewer filter. This work was carried on by Mr. Dumont, a graduate student. In the course of it he found, identified and described: *Oscillatoria limosa, Arthrospira junneri, Mougeotia sphærocopia, Ulothrix subtilis, Binulearia* sp., *Cladophora crispata, Monhysteria* sp., *Rhabditis* sp., *Plectus* sp., *Nais* sp., *Dero* sp., *Naidum* sp., *Pristina* sp., *Timnodrilus* sp., *Tubifex* sp., and *Leucophenga* sp.

The first six are species of algæ and the following three are Nematodes, the next eight are Oligochæta and the last is a Dipterous insect.

During the year funds were appropriated by the Legislature for a cooperative substation for the study of the biology of sewage disposal. The sum of $5,000.00 was appropriated to the New Jersey Agricultural Experiment Station and $5,000.00 to the New Jersey State Department of Health to support this joint project.

Dr. R. O. Smith has been secured to head the work of the substation. Dr. Smith, under the title of sewage specialist, will begin his work on July 1, 1921.

REPORT OF MOSQUITO WORK

THOMAS J. HEADLEE

WILBUR M. WALDEN

Introduction

During the fiscal year ending June 30, 1921, the entomologist as executive officer in charge of mosquito work for the state, and Mr. Walden, assistant to the entomologist, have given their attention to: (1) ditching as many acres of salt marsh as available funds would permit under the authority of Chapter 134, Laws of 1906; (2) a study of special problems in connection with mosquito control; (3) a general oversight and inspection of the work of the county mosquito extermination commissions; and (4) making surveys, furnishing plans and estimates requested by boards of health, other organizations and individuals.

Experiment Station Drainage

Two contracts amounting to $3,500 each were placed, one in Berkeley and Lacey Townships of Ocean County, and in the other in Upper Township in Cape May County. A formal report of the operation is here given. Advertisements were placed in the various papers as required by law and bids were submitted as follows:

On November 10 for cutting 50,000 feet or more or its equivalent of 10 by 30 inch ditching in Berkeley and Lacey Townships of Ocean County:

Brown and Simpson	$.0497 per foot
Harold I. Eaton	$.0385 per foot
U. S. Drainage and Irrigation Company	$.0375 per foot

Due to the fact that the U. S. Drainage and Irrigation Company submitted a check not certified as specified by law, Dr. Lipman referred the entire case to the attorney-general of the state. According to the latter's ruling, the U. S. Drainage and Irrigation Company did not comply with the law and Harold I. Eaton, the next lowest bidder, was awarded the contract. Work was started on December 4 but was discontinued.

On December 10, for cutting 100,000 feet or more or its equivalent of 10 by 30 inch ditching in Upper Township of Cape May County:

Brown and Simpson	$.0303
Harold I. Eaton	$.0220

Harold I. Eaton, being the lowest bidder, was awarded the contract. On account of the nature of the territories to be ditched Mr. Eaton decided to start work on the Cape May County contract first, so on December 15 work was begun at a point where the last ditching in a previous contract had been cut.

It was through the exceptionally mild winter that but 10 days were lost on account of temperature and rain. Three days were lost on account of breakdowns on the tractor. As a result of losing so little time, the first half of the contract was complete by January 20 and the entire work was finished and approved by February 25, 159,091 feet of ditching in all having been cut.

Attention should be called to the hearty cooperation of the property owners. In all cases the drainage system was laid out with a view to keeping clear an open space for the owner to drive his mowing machine on hard ground rather than over ditches and to save him needless expense in building bridges. In every case the ditching was laid out in the presence of the owner and with his approval.

The entire section as shown on the map (fig. 3) was ditched with the exception of a stump-bottom lot at the upland. This was skipped after a conference with the contractor and a decision rendered that the contract did not include that sort of ground to be ditched.

An inspection last June showed that the meadows ditched were dry enough to allow one to walk over them with ordinary shoes, boots not being necessary.

The contract on Island Beach in Lacey and Berkeley Townships was taken up again March 5. The entire contract was dug by hand, and in all cases except where greater width was required, the ditches were 15 inches wide and dug to the depth of the sod. The turf in this section was 4 to 15 inches in depth and lay on pure white beach sand which prevented digging deeper. No regular system of ditching could be laid out on account of the numerous sand dunes; it was necessary to dig the ditches around them except in a few cases where there was no other expedient but to cut the ditch directly through. Ditches were dug around in all possible cases so they would remain open, as the sand in the dunes constantly filled in ditches that were cut through.

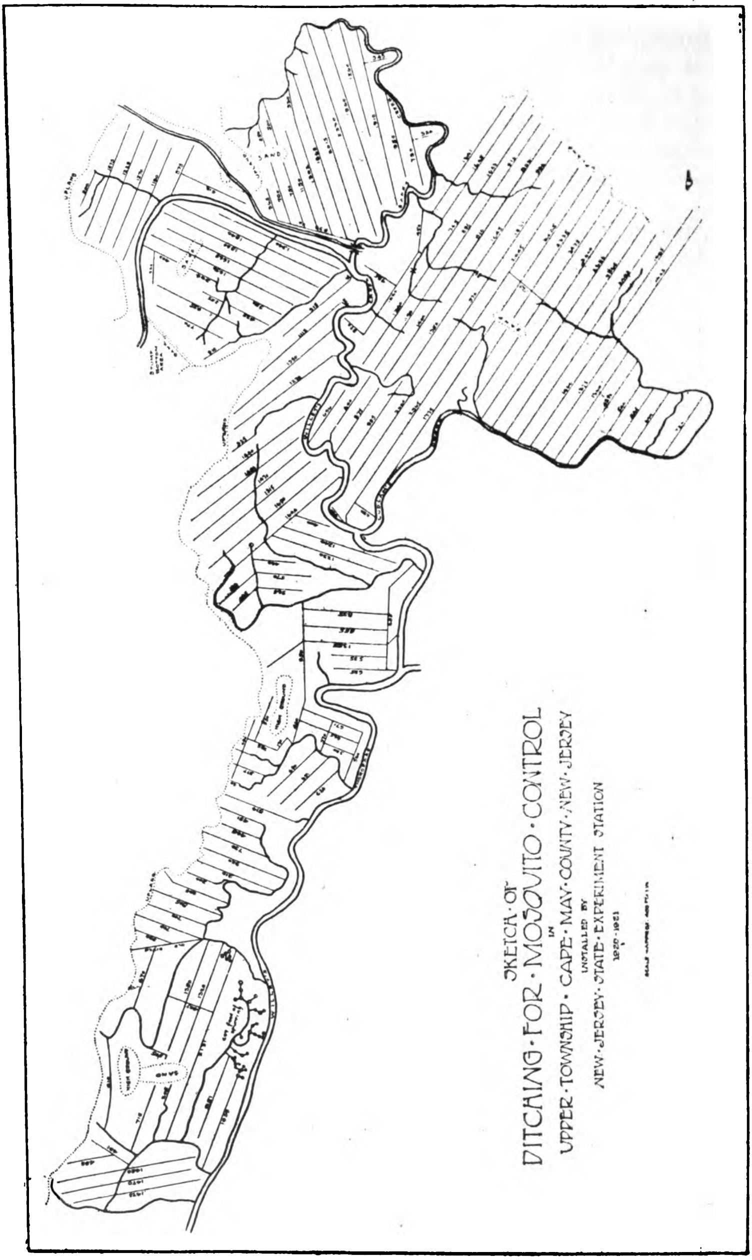
SKETCH OF
DITCHING · FOR · MOSQUITO · CONTROL
IN
UPPER · TOWNSHIP · CAPE · MAY · COUNTY · NEW · JERSEY
INSTALLED BY
NEW · JERSEY · STATE · EXPERIMENT · STATION
1920-1921
UPLAND
SAND
HIGH GROUND

FIG. 3. MAP OF DITCHING FOR MOSQUITO CONTROL, UPPER TOWNSHIP, CAPE MAY COUNTY, N. J.

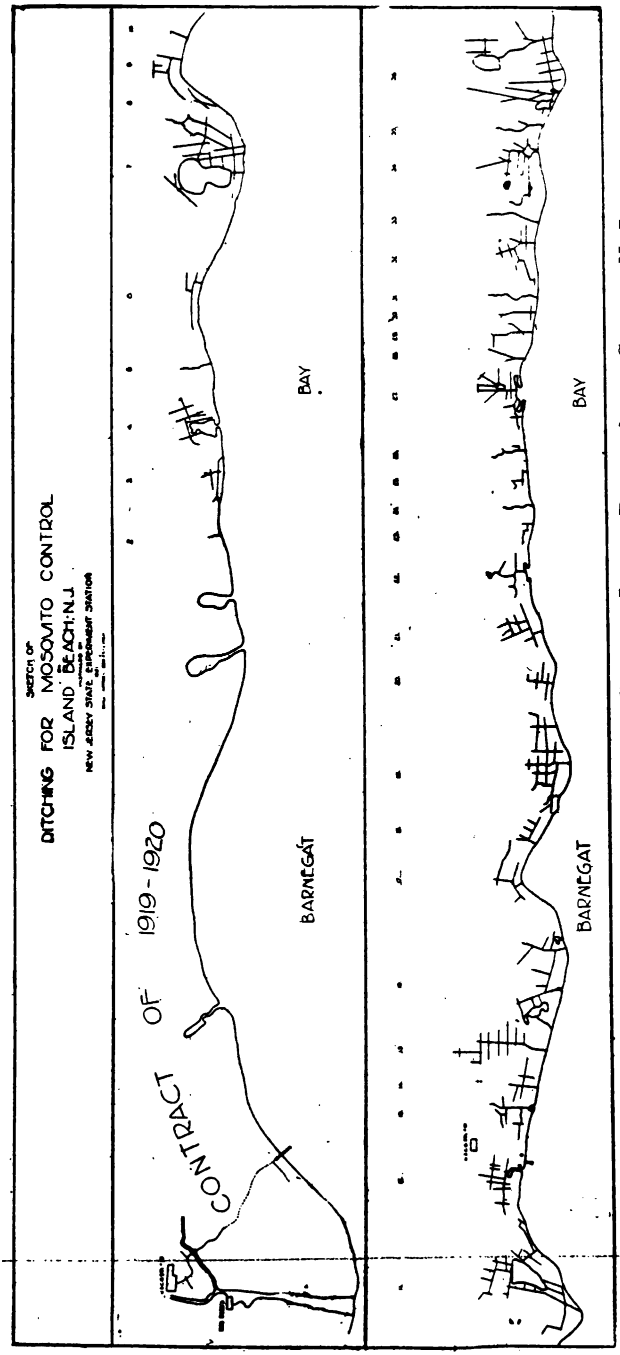

FIG. 4. MAP OF DITCHING FOR MOSQUITO CONTROL, ISLAND BEACH, OCEAN COUNTY, N. J.

The map (fig. 4) shows that there were 36 separate jobs in all and 45 outlets. The outlets have to be cleaned periodically on account of the rising tides filling them with sand and a 10-day cleaning patrol is now in force by the Ocean County Mosquito Commission. Being almost impossible to make a map of such a section without spending considerable time, an æroplane map was procured from the U. S. Coast and Geodetic Survey showing the principal ponds, many of the old ditches of a previous contract and an excellent outline of the shore. These features allowed orientation.

The contract specified that the work was to be done by April 1 and the contractor cut the last ditch on March 31, making in all 90,909 feet of ditching installed. There were but 5 days lost on account of bad weather.

Special Problems

Outlets

As was noted above, the rising tides clog the outlets with sand, thereby cutting off all drainage. Last year, in accordance with the suggestion of the senior author a wooden outlet was installed which ran out under the beach with its outlet in the bay and with a tide-gate hung where the water from the swamp entered the flume. Considerable trouble was experienced with continual clogging of the flume, so it was decided to observe conditions during the entire summer to ascertain if possible a means of keeping the flume open. Immense quantities of seaweed came floating in on the beach with high tide and westerly wind, making sometimes a mass 75 feet in width. Such masses of seaweed soon formed sand shoals and the chimney on the end of the flume was clogged continuously. Screens were placed on both ends to keep out the seaweed from the bay side and the algæ from the swamp, but these soon proved useless, making the clog tighter than ever. Therefore, the screens were removed. It was observed that the tide-gate was not functioning so it was removed also. As the result of a storm, a quantity of water had been stored up in the swamp forming considerable head. With the removal of the screens and the tide-gate the water rushed out and scoured the flume clean, and it has remained clean ever since. The water rises and falls with the tide and the fish are allowed in this way to get into the swamp.

This year another outlet similar to the above was installed with the exception that cast-iron pipe with bolted flanges was used instead of the wooden flume. This was tried for the following reasons; (1) the simplicity of installation and the resultant saving of time; (2) the doing away with all coffer damming and piling; (3) the guarantee of the pipe for 50 years. While the initial cost of the pipe was more than of the wooden flume, its ease of installation and its durability more than offset its difference in the cost. The total cost of the two jobs was practically the same.

Larvicides

Experiments have been carried on with two larvicides during the past season, one submitted by H. F. Kitchell of Dunellen, N. J., and the other by the Sanitas Company of Brooklyn, N. Y.

In the case of the first, two fresh-water pools and one salt-marsh pool were chosen. A proper amount of larvicide was prepared and placed in the two fresh-water pools and in 30 minutes the larvæ were dead. In 10 days, however, breeding was again observed. In the salt-water pool the solution would not emulsify at all. Admitting that the larvæ were killed in the fresh-water pools, its price was too high to compete successfully with the fuel oils now used to advantage. Its greatly advertised feature was its ability to remain in solution thus preventing breeding in that pool for one month at least. Its failure in this regard and the price, together with the fact that it was useless in salt water, showed that as a mosquito larvicide it was of little use.

In the second case, a mixture called "Sanitas Okol" was prepared. The chemist sent to observe the experiment was Eugene Kohn, of the Pease Laboratories, of Brooklyn. A solution of 1 to 10,000 was made and two fresh-water pools were selected. There were larvæ and pupæ in each pool. In the first pool there was a noticeable reduction of the pupæ, but many emerged despite the larvicide. In the second pool no larvæ were killed. The solution did not mix well with water unless thoroughly agitated. It was found that it did not emulsify in salt water at all, so that part of the experiment was given up. As in the case of the first experiment it was decided that Sanitas Okol was not suitable for mosquito-extermination purposes.

County Commission Work

During the year just passed, Hudson, Bergen, Essex and Union have continued their efforts to control mosquitoes throughout the limits of their territory. Passaic has continued its efforts to control mosquitoes in the southern half of the county. Middlesex, Monmouth, Ocean and Cape May have continued to devote their attention and funds to salt-marsh drainage and maintenance. Atlantic has continued to devote the bulk of its funds to salt-marsh mosquitoes and also to control fresh-water breeding in the important urban centers of the county.

The year has seen 120,000 acres of salt marsh regularly patrolled and in so far as practicable all breeding thereon destroyed; and 320,000 acres of upland regularly patrolled and in so far as practicable all breeding found destroyed.

The salt marsh gave forth broods in a normal way, that is, during the summer season each monthly perigee high tide initiated a brood and more or less of it escaped. Large broods escaped from the undrained areas and small broods or none from the drained areas.

As usual, the brown salt-marsh mosquito (*Aedes cantator*) was the prevailing form emerging from the salt marsh through the northern half or more of the state. During the first broods it was present through the southern half of the state. As the season progressed its place was taken by the white-banded salt-marsh mosquito (*Aedes sollicitans*), with the exception of the territory comprised of the Upper Hackensack Valley, where such salt-marsh mosquitoes as breed belong almost if not quite exclusively to the former species. The small salt-marsh mosquito (*Aedes tæniorhynchus*) was present as usual. There was nothing of an unusual character in the salt-marsh emergence during the past year. The house mosquito (*Culex pipiens*) and the fresh-water swamp mosquito (*Aedes sylvestris*) likewise showed no unusual feature. The malaria mosquito (*Anopheles quadrimaculatus*), however, showed a considerable extension of some of its normal areas and the disease of malaria was more widespread during this year than for many years previous.

The beneficial results of mosquito control have continued to appear in the increased improvement of the industrial sections of the salt-marsh and territory adjacent thereto, and in the seashore resort and urban development.

The county commissions have not only maintained the salt marsh (17½ million feet) and upland drainage already established, but have increased the amount of salt-marsh drainage by 2,052,637 linear feet of the ditching 10 inches wide and approximately 30 inches deep. On the basis of 300 feet to the acre, this new drainage on the salt marsh would represent 6,842 acres.

The amount of new upland drainage established by the commissions is indeterminate but large. The status of drainage on the salt marsh is set forth in table 1.

Table 1

Salt-Marsh Drainage in New Jersey, Reckoned in Ditches 10 Inches Wide and 30 Inches Deep

YEAR	HUDSON COUNTY		BERGEN COUNTY		ESSEX COUNTY		UNION COUNTY		MIDDLESEX COUNTY	
	State Experiment Station	County Commission	State Experiment Station	County Commission	State Experiment Station	County Commission	State Experiment Station	County Commission	State Experiment Station	County Commission
	feet	feet	feet	feet	feet	feet	feet	feet	feet	feet
1902 to 1912	171,350	113,500	....	....	217,800	618,000	707,812	372,112	505,800	....
1913	....	100,000	....	....	....	350,000	....	25,000	30,000	....
1914	....	126,000	....	....	....	....	25,000	37,385	....	52,800
1915	....	150,000	346,282	155,000	....	30,098	....	129,777	....	116,564
1916	....	140,000	....	150,000	....	69,057	....	13,814	....	186,100
1917	....	109,943	....	....	....	30,000	....	57,941	....	35,051
1918	....	9,665	....	22,500	....	10,095	....	1,500	....	45,051
1919	....	145,488	....	58,000	....	39,923	....	8,000	....	97,873
1920	....	50,348	....	750,164	....	21,000	....	4,000	....	61,200
Totals	171,350	944,944	346,282	1,135,664	217,800	1,168,173	732,812	649,529	535,800	594,639
Grand Totals	1,116,294		1,481,946		1,385,973		1,382,341		1,130,439	

Table 1—Continued

Salt-Marsh Drainage in New Jersey, Reckoned in Ditches 10 Inches Wide and 30 Inches Deep

YEAR	MONMOUTH COUNTY		OCEAN COUNTY		ATLANTIC COUNTY		CAPE MAY COUNTY		CUMBERLAND COUNTY		Totals Yearly
	State Experiment Station	County Commission	State Experiment Station	County Commission	State Experiment Station	County Commission	State Experiment Station	County Commission	State Experiment Station	County Commission	
	feet	feet	feet	feet	feet	feet	feet	feet	feet	feet	
1902 to 1912	553,700	237,500	1,954,380	15,000	....	....	....	....	630,000	....	6,096,954
1913	....	....	399,842	....	260,000	404,365	....	....	....	....	1,569,207
1914	....	245,872	....	....	271,601	828,367	....	....	....	....	1,587,025
1915	....	25,000	....	30,000	....	1,325,100	209,634	....	....	....	2,517,455
1916	....	136,000	....	339,520	....	1,391,912	....	132,239	....	....	2,558,642
1917	....	46,476	119,285	538,277	....	323,907	101,987	161,479	....	....	1,524,346
1918	....	7,000	137,931	360,097	....	305,003	137,931	161,479	....	....	1,198,252
1919	....	22,576	90,074	336,946	....	311,331	140,000	116,980	....	....	1,367,191
1920	....	63,800	90,909	328,219	....	406,455	159,091	117,451	....	....	2,052,637
Totals	553,700	784,224	2,792,421	1,948,059	531,601	5,296,440	748,643	689,628	630,000	....	....
Grand Totals	1,337,924		4,740,480		5,828,041		1,438,271		630,000		20,471,709

As the county mosquito commission work has developed, commission employees have become highly trained and experienced in the practical work of control. For a number of years executives in charge of mosquito-control work have had an unofficial organization which held more or less regular meetings where common problems could be discussed and ideas interchanged. This organization has recently taken on the name of the Associated Executives of Mosquito-Control in New Jersey, and has been recognized by the New Jersey Mosquito Extermination Association as a useful and proper instrument in furthering the work of control itself.

The New Jersey Mosquito Extermination Association has continued its work of educating its membership and crystallizing anti-mosquito sentiment throughout the state. It held one regular meeting during the year in which the status of mosquito-control work in New Jersey and the country was considered through the medium of papers presented by the men who have been engaged in carrying on the practical work itself.

Extending Aid to Boards of Health, Other Organizations and Individuals

During the year mosquito campaigns were started in Mountain Lakes, Franklin, Somerville and Flemington.

On March 29 an inspection and a survey were made in Mountain Lakes at the request of the Mountain Lakes Association. The inspection showed that one source of annoyance was from the swamps and woodlands about Tabor, north of Denville, and the extensive Lee and Troy meadows, but inasmuch as flights from these meadows were rare the effect would not be felt more than a week at a time. Locally bred mosquitoes would form the main annoyance in spots, but a very dangerous area lies to the southwest in a swamp and woodland, a quarter of a mile east of the Fox Hills Crossing on the Denville and Pine Brook Turnpike. It would require too much money thoroughly to drain all the surrounding territory in one season, so temporary measures were suggested such as oiling, etc. All local breeding places such as cans, pails, roof gutters, barrels, etc., could be destroyed.

On April 27, at the request of Mrs. Mabel Clarke, Health Officer of Franklin, this department made a survey to determine if conditions warranted a campaign of extermination. No larvæ were found on account of a recent oiling of all places by the board of health under the direction of Mrs. Clarke, but a thorough inspection was made with reference to draining, filling in, etc., and also a scheme for periodic inspections. A definite plan was made and submitted to both the mayor and the president of the board of health, who were in hearty accord. Recent reports show that the work has produced results.

Last May the mayor of Somerville appointed a mosquito commission of three members for extermination work in that town, and at the request of its chairman, Dr. Launcelot Ely, the junior author attended a meeting on May 12, when plans were prepared and discussed. A superficial inspection was made with the entire commission; the character of the places visited and the amount of mosquito breeding found justified beginning work at once.

At a meeting of the borough council the plans and evidence were submitted and an appropriation of $800 was granted to start the work. Circulars describing the entire work were printed and distributed and an inspector was hired.

Excellent progress has been made, and a report to this office shows that considerable work has been done and noticeable results accomplished.

Interest in a campaign started in Flemington was aroused by the women's club through their activity in the local board of health. At their request a survey was made on May 23 and breeding was found throughout the town in large quantities. A plan of procedure was made and at once carried out. An exhibit was arranged in the window of the National Bank on the main street and later in the rooms of the Red Cross. This exhibit was the means of arousing public interest. Shortly afterward oil was purchased and an inspector hired to get the work under way. Results have been noted in fewer mosquitoes on the wing.

Financial Statement of the State Experiment Station's Mosquito Work

Total appropriation		**$16,500.00**
Salt marsh ditching contracts	**$7,000.00**	
Salaries and wages	**6,125.84**	
Advertising for proposals	**53.04**	
Express, freight and cartage	**25.52**	
Office and field equipment	**219.14**	
Materials for installation of two sluiceways	**450.00**	
Miscellaneous hour and day labor	**319.00**	
Blue prints and photographic supplies	**64.81**	
Postage	**60.00**	
Small printing and stationery	**3.75**	
Telephone and telegraph	**67.43**	
Traveling expenses	**2,040.02**	
Reverting to State Treasury	**71.45**	
		$16,500.00

REPORT OF THE DEPARTMENT OF PLANT PATHOLOGY

Department of Plant Pathology

Melville T. Cook, Ph.D., *Plant Pathologist.*

William H. Martin, Ph.D., *Associate Plant Pathologist.*

Robert F. Poole, Ph.D., *Assistant Plant Pathologist.*

C. M. Haenseler, Ph.D., *Assistant Plant Pathologist.*

***Gordon W. Fant, B.Sc.,** *Fellow and Assistant in Plant Pathology.*

William D. Moore, B.Sc., *Fellow and Assistant in Plant Pathology.*

***Appointed August 1, 1920.**

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Report of the Department of Plant Pathology

MELVILLE THURSTON COOK

INTRODUCTION

The organization of the department during the past year was very similar to that of the preceding year. Dr. Wm. H. Martin, associate plant pathologist, continues with us as potato specialist and devotes a considerable part of his time to the study of the diseases of potatoes. His special problems in pathology were the control of common scab of the potato by the use of sulfur and spraying for the control of foliage diseases. His report will be found on p. 435-460.

Dr. R. F. Poole, fellow in plant pathology and assistant plant pathologist in charge of work on diseases of sweet potatoes and tomatoes, completed his work on "The Root Rot of the Celery" and received the degree of Doctor of Philosophy on June 14. He has also done considerable work on the root rot of the horse-radish (p. 461-468). He will continue with us as assistant plant pathologist, giving practically all of his time to the study of the diseases of sweet potatoes and tomatoes.

Dr. C. M. Haenseler, New Jersey Zinc Company Fellow, completed his work on "Fungi Injurious to Paints" and received the degree of Doctor of Philosophy on June 14. During the past year he did some work also on the control of the pear fruit and leaf spot (p. 473-474) and the eggplant wilt (p. 469-472). He will continue with us next year as instructor in botany and plant pathology.

William D. Moore (Clemson College, 1920) is fellow and assistant in plant pathology. He is giving special attention to the study of the root rots of corn and peas.

Gordon W. Fant (Clemson College, 1920) is fellow and assistant in plant pathology. He is giving special attention to the study of the brown rot of the peach and to seed-bed diseases.

Research

The research work in progress involves the following problems:

In the charge of Mel. T. Cook:
1. The influence of Bordeaux and other spray mixtures on potatoes.
2. The influence of mosaic and leaf roll on the yield of potatoes.
3. The transmission of *Sclerotinia cinerea* from year to year.
4. Studies on the morphology of peach yellows.
5. Causes of tomato rots.
6. Removal of fruit-tree cankers.
7. Diseases of licorice.

In the charge of Wm. H. Martin:
1. Control of foliage diseases of the potato by applications of Bordeaux mixture.
2. Investigation of the use of elemental sulfur for the control of common scab of potatoes.
3. A study of the fertilizer requirements of potatoes.
4. Investigations of tuber-borne diseases.
5. Physiological studies of seed potatoes.

In the charge of R. Frank Poole:
1. Root rot of celery.
2. Root rot of horse-radish.
3. A study of stem rot control of sweet potatoes by seed selection.
4. A study of soil treatments as affecting the control of "soil rot," "pit" or "pox" of sweet potatoes.
5. A study of the dissemination and cause of scurf of sweet potatoes under different soil conditions.
6. A study is being made in general of all storage and field rots of sweet potatoes.

In the charge of C. M. Haenseler:
1. A new wilt disease of the peach.

In the charge of W. D. Moore:
1. Root rot of the pea.
2. Root rot of corn.
3. Control of cherry leaf spot.
4. Control of strawberry leaf spot.

In the charge of G. W. Fant:
1. Brown rot cankers of the peach.
2. Control of seed-bed diseases.
3. Control of the fruit and leaf spot of the pear.
4. Comparative testing of spray and dust for control of apple diseases.

Publications

The Station publications contributed during the year by the department of plant pathology are Bulletin 345, Circulars 122 and 123, and papers of the Journal Series, Nos. 12, 21, 26, 27, and 29.

EPIDEMICS

The rainfall during the spring, summer and fall of 1920 was heavier than usual and weather conditions were very similar to those of 1919. The winter of 1920-21 was exceptionally mild. The early part of March, 1921, was very warm, followed by freezing weather the latter part of March and the early part of April. Several diseases have been severe enough to be listed as epidemics. They are as follows:

1. *The brown rot of the peach* was exceptionally severe in 1919 and 1920, the blossom blight form being very abundant. The early frosts in 1921 killed most of the peach buds. The blossom-blight form of brown rot was severe in some few orchards that escaped the frost.
2. *The late blight of the potato* was very abundant during the latter part of the season of 1920. A more complete discussion will be found on page 435.
3. *The common scab of the potato* was very abundant again in 1920. Dr. Martin reports more fully upon its prevalence, and his studies on its control by the use of sulfur (page 442).
4. The leaf spot of the cherry was very destructive in 1920. It was the subject of one orchard experiment by Dr. C. M. Haenseler and is reported on page 442. It is very severe also in 1921.
5. *The eggplant wilt* continues to be a very important disease. It was the subject of an experiment by Dr. Haenseler and is reported on page 469.
6. *The black leg of the cabbage* is a destructive disease which was very abundant in some places, especially in Camden county. This crop should receive special attention of a well trained plant pathologist.
7. *A disease of tomatoes* which we have designated as *streak* was very destructive. This disease has been observed for several years but was not of much importance until 1920. The Experiment Station literature for a period of nearly thirty years contains references to this or a very similar disease. The disease is more or less prevalent in the greenhouses during the winter and has been the subject of special study by Dr. C. R. Orton of the Pennsylvania Experiment Station. The same or a similar disease is reported from the Pacific Coast. It may be the same as the Grand Rapids wilt. It should receive careful attention of a trained plant pathologist.
8. *A bacterial rot of seed potatoes* after planting was very prevalent in the state, especially in Monmouth county during the early spring of 1921. It was mostly due to *Bacillus vulgarus* but was complicated by the presence of a small amount of *Fusarium* sp. and by wire-worms in many fields. In some cases the losses were quite heavy.

OTHER IMPORTANT DISEASES

Other very important diseases which are worthy of special attention are:

1. *The root rot of the pea* which was so very destructive in 1919 was of little importance in 1920, but an examination of the fields showed that the organism was present. Evidently the weather conditions were unfavorable for its development. It is very destructive in 1921 and will probably result in reduced acreage in the future. Mr. Moore is giving some attention to the problems but it is of sufficient importance to require the full time of a trained man.

2. *The leaf and fruit spot of the pear and quince* (*Fabrea maculata*) (Lev. Atk.) was quite severe on the foliage but the pear crop was small. Experimental spraying for the control of this disease was carried on by Dr. C. M. Haenseler. The results are given on page 473. The work is being continued by Mr. Fant.

3. *The root rot of celery* is the subject of Dr. Poole's special work. A brief report of his work will be found on page 461. A complete report will be published in bulletin form.

4. *The root rot of corn* was less severe than usual but is of such great importance that it has been assigned to Mr. Moore for special study.

5. *The root rot of horse-radish* continues to be a very destructive disease. Dr. Poole's report on this disease will be found on page 464.

6. *The cherry leaf spot* was very severe in 1920 and again in 1921. It was the subject of an orchard test.

7. *The diseases of small fruits* are the causes of very heavy losses which are not generally recognized by the growers. We should have a careful survey of these diseases and some provisions should be made for their study.

8. *The Fusarium wilt* of the tomato is prevalent in South Jersey and the growers do not realize its importance. It should receive attention from the standpoint of developing resistant varieties. It is likely to become an extremely serious disease in the very near future.

9. *Seed-bed diseases* due to several causes are becoming more and more important. This problem has been assigned to Mr. Fant for special study.

COOPERATIVE WORK WITH THE STATE DEPARTMENT OF AGRICULTURE

A great deal of the work of this department is closely associated with the work of the New Jersey Department of Agriculture. Unfortunately, we do not have the necessary funds for scouting for such diseases as potato wart and blister rust of the white pine, which are likely to be introduced at any time. Fortunately there has been no cases of "take all," flag smut or nematode of wheat reported thus far. The nurseries are inspected annually and a close watch is kept on nursery stock coming into the state. Certification of seed potatoes is being carried on with encouraging results. Some little scouting is done in cooperation with the United States Bureau of Plant Industry.

NEEDS OF THE DEPARTMENT

The force of workers is not large enough to meet the increasing demands for work on plant diseases. Consequently, workers in other departments, who are not trained in plant pathology, sometimes respond to these demands with results that are not altogether satisfactory. The greatest efficiency and economy cannot be obtained by employing men to do work for which they are not trained.

The most urgent needs are as follows:

1. A well trained plant pathologist is needed to conduct and direct many of the field tests which are urgently needed. Some of this work could very properly be handled by a well trained extension pathologist.

2. One or more well trained men are needed for research on the more complicated and difficult diseases, such as yellows, mosaics and similar diseases.
3. We are in very great need of a trained plant pathologist to conduct experimental work for the development of disease-resistant strains. This is one of the most fruitful lines of work for development at this time. Some of the most important problems are the root rot of the pea, the wilt of the tomato, the wilt of the eggplant and the black leg of cabbage.
4. The diseases due to soil organisms, especially the wilt diseases, are attracting more and more attention. They are complicated with such physiological factors as moisture and temperature and require the attention of especially trained men.
5. The diseases of grain and forage crops, small fruits and vegetables are causing heavy losses and should receive attention. The losses are not appreciated by the growers.
6. Many of the storage rots of fruits and vegetables, especially sweet potatoes, are due to the same organisms as those that cause heavy losses in the field. Much of the loss in transportation also is due to these same causes. These problems should be studied by trained men.

THE HERBARIUM

The herbarium, which was at one time an exceptionally good collection of plants for study, has been neglected for many years. We are in great need of a well kept herbarium of parasitic fungi. Our working conditions are such that we have not added to nor given proper care to the existing collections. The mounted plants should be gone over very carefully and put in place and the large collection of unmounted plants (mostly fungi) should be mounted and carefully distributed so that they can be used. Prof. G. W. Martin has given some attention to this work during the past year but his time has been very limited. In connection with the herbarium some arrangements should be made for keeping a more satisfactory record of the diseases reported each year.

DISEASES OF THE YEAR

The most important diseases of the year as collected by the members of the department and sent in by correspondents are as follows:

Alfalfa

LEAF SPOT (*Pseudopiziza medicaginis* (Lib.) Sacc.). This disease was very severe but probably no more severe than in previous years. The diseased leaves fall more readily than healthy leaves and the loss is quite heavy.

OTHER LEAF SPOTS due to various causes which have been recorded in previous reports were found occasionally but were of no importance.

Ampelopsis

LEAF SPOT (*Phyllosticta ampelopsidis* Ell. & Mart.). This disease was less prevalent than usual and of little importance.

Apple

Crown Gall and Hairy Root (*Bacillus tumefaciens* S. & T.). Common on the apple and many other plants. Many apple and peach trees are no doubt weakened by this disease. It is doubtless the cause of poor growths in many cases.

Black Rot (*Sphæropsis malorum* Pk.). Very common but no more severe than usual.

Bitter Rot (*Glomerella rufomaculans* (Berk.) S. & van S.). Present but not a serious disease.

Blossom End Rot (*Alternaria* sp.). Very common but not serious. It is very often associated with arsenical injury.

Jonathan Spot (*Alternaria* sp.). Very abundant.

Fire Blight (*Bacillus amylovorus* (Burr.) DeToni). Not serious in many orchards.

Blotch (*Phyllosticta solitaria* E. & E.). Very severe on the Smith Cider variety.

Sooty Blotch (*Phyllachora pomigena* (Schu.) Sacc.). Not important in well sprayed orchards.

Scab (*Venturia inequalis* (Cooke) Wint.). Common, especially in unsprayed orchards. More prevalent in 1921 than in 1920.

Rust (*Gymnosporangium juniperi-virginianæ* Schw.). Very severe in a few localities.

Fruit Spot (*Cylindrosporium pomi* Brooks). Quite serious in several orchards which were not well sprayed.

Mildew (*Sphærotheca mali* (Duby) Burr.). Occasional.

Blister Canker (*Numularia discreta* (Schw.) Tull.). Occasional.

Stippen (?). Very common.

Water Core (?). Occasional.

Low Temperature in early spring, resulting in leaf fall later in the season.

Asters

Yellows (cause unknown). This disease is more or less prevalent every year.

Wilt (*Fusarium* sp.). Occasional.

Beans

Anthracnose (*Colletotrichum lindemuthianum* (Sacc. & Magn.) Bri. & Cav.). Prevalent throughout the state and destructive.

Leaf and Pod Spots (*Diaporthe phaseolus* (C. & E.) Sacc.). Prevalent especially in the southern part of the state, but not very destructive.

Downy Mildew (*Phytophthora phaseoli* Thaxter). Very abundant and very severe throughout the state.

Root Rot (*Rhizoctonia*). Very common on the roots and sometimes very destructive.

Rust (*Uromyces appendiculatus* (Pers.) Lev.). Rare.

Bacterial Blight (*Pseudomonas phaseoli* E. F. Smith). Occasional early in the season. More prevalent than usual in 1921.

Beets

Leaf Spot (*Cercospora beticola* Sacc.). Very abundant but not considered of any importance.

Blackberry

ANTHRACNOSE (*Glœosporium venetum* Speg.). Common but of relatively little importance.

LEAF SPOT (*Septoria rubi* West). Common but of very little importance.

RUST (*Gymnoconia peckiana* (Howe) Tranz.). Common and sometimes destructive.

(See Dewberry and Raspberry)

Cabbage, Cauliflower and Kohlrabi

BLACK LEG (*Phoma lingam* (Tode) Desmaz.). Prevalent in the southern part of the state and very severe in Camden county.

YELLOWS (*Fusarium conglutinans* Wollenw.). Occasional.

BLACK ROT (*Pseudomonas campestris* (Pammel) Smith). Occasional, and widely distributed throughout the state.

CLUB ROOT (*Plasmodiophora brassicæ* Wor.). Occasional. Sometimes very destructive.

Cantaloupe

(See Muskmelon)

Carnation

RUST (*Uromyces caryophyllinus* (Schrank) Wint.). Common but not serious.

ROOT ROT (*Corticium vagum* B. & C. var. *solani* Burt.). Common but not serious.

Catalpa

LEAF SPOT (*Phyllosticta catalpæ* Ell & Mart.). Common and sometimes the cause of heavy leaf fall.

Cedar

RUST (*Gymnosporangium juniperi-virginianæ* Schw.). Very abundant in restricted localities throughout the state. Reported from Monmouth, Burlington and Cape May counties.

Celery

EARLY LEAF BLIGHT (*Cercospora apii* Fr.). Abundant in the celery-growing districts throughout the state.

LATE BLIGHT (*Septoria petroselini* Desm. var. *apii* Br. & Car.). Abundant in the celery-growing districts throughout the state.

ROOT ROT (*Sclerotinia libertiana* Fckl.). Occasional, sometimes severe.

CROWN AND HEART ROTS (*Bacterial*). Very severe in some localities (page 461).

Cherry

BROWN ROT (*Sclerotinia cinera* (Bon) Schrot.). Abundant and very destructive.

LEAF SPOT (*Cylindrosporium padi* Karst.). Abundant and destructive.

LOW TEMPERATURE in early spring, resulting in leaf fall later in the season.

Chestnut

BLIGHT (*Diaporthe parasitica* Murrill). Abundant.

Clover, Red

RUST (*Uromyces trifolii* (Hedw.) Lev.). Common but of no importance.

Corn

SMUT (*Ustilago zeæ* (Beckm.) Urg.). Very common and in some cases serious.

WILT (*Fusarium* (?)). Widely distributed throughout the state. It is the subject of special study.

WILT (*Pseudomonas stewarti* E. F. Smith). Occasional in northern part of state. Of no importance.

RUST (*Puccinia sorghii* Schw.). Occasional but of no importance.

LEAF BLOTCH (*Helminthosporium inconspicuum* C. & E.). Common.

Cowpea

LEAF SPOT (*Cercospora dolichii* E. & E.). Common.

Cranberry

SCALD (*Guignardia vaccinii* Shear). Widely distributed and very abundant in the cranberry bogs of the state.

ROT (*Acanthorynchus vaccinii* Shear). More or less common.

ANTHRACNOSE (*Glomerella rufomaculans vaccinii* Shear). *Glœosporium* stage common.

Cucumbers

LEAF SPOT (*Macrosporium cucumerinum* C. & E.). Common and destructive.

DOWNY MILDEW (*Plasmopara cubensis* (B. & C.) Humphrey). Common and destructive.

WILT (*Bacillus tracheiphilus* (E. F. Smith). Very common.

STEM ROT (*Sclerotinia libertiana* Fckl.). Common on plants grown under glass.

Currant

ANTHRACNOSE (*Glœosporium ribis* (Lib.) M. & D.). Very common.

LEAF SPOT (*Septoria ribis* Desm.). Common.

CANE BLIGHT (*Botryosphœria ribis* G. & D.). Common and very destructive.

RUST (*Cronartium ribicola* Kleb.). Reported from two localities.

Dewberry

ANTHRACNOSE (*Glœosporium venetum* Speg.). Common and sometimes severe.

DOUBLE BLOSSOM (*Fusarium rubi* Wint.). Abundant and sometimes injurious.

RUST (*Gymnoconia interstialis* (Howe) Franz.). Common and sometimes destructive.

LEAF SPOT (*Septoria rubi* West.). Very abundant but of little importance.

Eggplant

LEAF BLIGHT (*Phomopsis vexans* (Sacc. & Gyd.) Harter). Abundant and in some cases destructive.

WILT (*Verticillium albo-atrum* R. & B.). Common and destructive throughout the state (page 469).

Gooseberry

ANTHRACNOSE (*Pseudopeziza ribis* Kleb.). *Glœosporium* stage common.
LEAF SPOT (*Septoria ribis* Desm.). Common.

Grape

BLACK ROT (*Guignardia bidwellii* (Ell.) V. & R.). Abundant and severe.

DOWNY MILDEW (*Plasmopara viticola* (B. & C.) D. T.). Common but not serious.

NECROSIS (*Fusicoccum viticolum* Reddick). Rare.

CHLOROSIS. Caused the loss of several plants in one locality (Glassboro). Cause undetermined.

Hollyhock

RUST (*Puccinia malvacearum* Mont.). Very common.

Horse Chestnut

LEAF SPOT (*Guignardia æsculi* Stewart). Very common.

Horse-Radish

Rot (Bacterial). Very common and very destructive in one locality (page 464).

ROOT ROT (*Thielavia basicola* B. & Br.) Common and sometimes destructive.

Lettuce

DROP (*Sclerotinia libertiana* Fckl.). Common and sometimes destructive.

Lilac

MILDEW (*Microsphæra alni* (Walls.) Wint.). Very common.
LEAF SPOT (*Phyllosticta halstedii* Ell.). Common.

Maple

TAR SPOT (*Rhytisma acerinum* (Pers.) Fr.). Occasional.

LEAF INJURIES (cold weather). Many complaints came in during the spring of 1921 concerning leaf injuries which were no doubt due to frost and unfavorable weather conditions.

Muskmelon

WILT (*Bacillus, tracheiplitis* E. F. Smith). Common and sometimes destructive.

DOWNY MILDEW (*Plasmopara cubensis* (B. & C.) Humphrey). Common and sometimes severe.

LEAF MOLD (*Alternaria brassicæ* (Berk.) Sacc.). Common and severe.

Oats

SMUT (*Ustilago levis* (K. & S.) Magnus). Common.
SMUT (*Ustilago avenæ* (Pers.) Jens.). Common.
RUST (*Puccinia coronata* Cda.). Common.

Okra

WILT (*Verticillium albo-atrum* R. & B.). Abundant in one locality.

Pea

LEAF SPOT (*Ascochyta pisi* Lib.). Occasional.

ROOT ROT (*Fusarium* sp.). Very abundant and very destructive. Heaviest losses in Burlington and Cape May counties.

Peach

BROWN ROT (*Sclerotinia cinerea* (Bon.) Schrot.). Abundant and destructive.

SCAB (*Cladosporium carpophilum* Thum.). Abundant in unsprayed orchards.

LEAF CURL (*Exoascus deformans* (Berk.) Fckl.). Abundant in orchards that have not been properly sprayed.

SHOT-HOLE (*Bacterium pruni* E. F. Smith). Abundant in some localities.

MILDEW (*Podosphœria oxycanthœ* (D. C.) DeBary). One case on the fruit in May, 1921.

YELLOWS. Common.

LITTLE PEACH. Common.

CROWN GALL (*Bacillus tumefaciens* S. & T.). Common.

WINTER INJURY. In some cases severe and dating back to 1917-18.

Pear

FIRE BLIGHT (*Bacillus amylovorus* (Burr.) DeToni). Common throughout the state and severe in a few orchards.

LEAF AND FRUIT SPOT (*Fabrœa maculata* Lev.). Very abundant and very destructive in some orchards, especially in the southern part of the state.

LEAF SPOT (*Septoria pyricola* Desm.). Abundant.

BROWN BLOTCH (Cause undetermined). Common.

SCAB (*Venturia pyrina* Aderh.). Common where the orchards have been neglected.

Pepper

ANTHRACNOSE (*Colletotrichum nigrum* E. & H.). Common.

ROT (*Macrosporium* sp.). Common on fruits, especially those that have been sunburned.

MOSAIC. Common but apparently of little importance.

SUN SCALD. Common and followed by fruit rots.

LEAF FALL (Cause unknown). Cause of heavy losses.

Pine

BLISTER RUST of white pine.

Plum

BLACK KNOT (*Plowrightia morbosa* (Schw.) Thum.). Common throughout the state.

BROWN ROT (*Sclerotinia cinerea* (Bon.) Schrot.). Common throughout the state and destructive.

Potato

BROWN STEM (*Rhizoctonia*). Common but not as destructive as in previous years.

BLACK LEG (*Bacillus phytopthorus* Appel). Rare in 1920; common in 1921.

SCAB (*Actinomyces chromogenus* Gast.). Much more abundant than usual.

EARLY BLIGHT (*Alternaria solani* (E. & M.) S. & G.). Abundant throughout the state.

LATE BLIGHT (*Phytophthora infestans* DeBary). Very abundant and very destructive.

MOSAIC. Very severe in some fields of Giants.

LEAF ROLL. Rare.

TIP BURN. Common.

ARSENICAL POISONING. Common and usually due to carelessness in application.

SEED PIECE ROT (*Bacillus vulgarus*). Prevalent in some parts of the state during spring of 1921.

SPINDLING SPROUTS. Common. Probably due to several causes.

Quince

BLACK ROT (*Sphæropsis malorum* Pk.). Very abundant and very severe.

FIRE BLIGHT (*Bacillus amylovorus* (Burr) DeToni). Common.

LEAF AND FRUIT SPOT (*Fabræa maculata* (Lev.) Atk.). Abundant and very severe.

RUST (*Rostellia aurentiana* Pk.). Occasional.

Raspberry

ANTHRACNOSE (*Glœosporium venetum* Speg.). Abundant and destructive.

LEAF SPOT (*Septoria rubi* West.). Abundant but of little importance.

CANE BLIGHT (*Leptosphœria coniothyrium* Fckl.). Common and sometimes destructive.

CROWN GALL (*Bacillus tumefaciens* S. & T.). Abundant and destructive.

Rose

ANTHRACNOSE (*Glœosporium rosæ* Hals.). Common but not serious.

LEAF BLOTCH (*Actinonema rosæ* (Lib.) Fr.). Common and very severe in greenhouses.

LEAF SPOT (*Phllostiata rosicola* Massal.). Abundant and sometimes confused with leaf blotch.

CANE BLIGHT (*Leptosphœria coniothyrium* (Sacc.) Fckl.). Common and sometimes serious.

POWDERY MILDEW (*Sphœrotheca pannosa* (Wallr.) Lev.). Common and frequently very injurious.

CROWN GALL (*Bacillus tumefaciens* S. & T.). Frequent and sometimes serious.

ROSE (*Botrytis* sp.). Causing a rotting of buds in the greenhouse.

Strawberry

LEAF SPOT (*Mycosphœrella fragariæ* (Tul.) Lidau). Common.

LEAF SPOT (*Ramularia tulasnei* Sacc.). Common.

WINTER INJURY. Occasional.

Sun-Flower

RUST (*Puccinia helianthii* Schw.). Occasional.

Sweet Potato

BLACK ROT (*Sphæronema fimbriatum* (E. & H.) Sacc.). Abundant.

STEM ROT OR YELLOW ROT (*Fusarium batatatis* Wollen. and *E. Hyperoxysporium*). Abundant and the cause of heavy losses (page 466).

SCURF (*Monilochætes infuscans* E. & H.). Very common.

ROTS (*Rhizopus nigricans* Ejr., *Diaporthe Batatatis* H. & F., *Sclerotium bataticola* Taub, *Tricoderma kœnigii* and *Penicillium* sp.). Very abundant, especially in storage.

POX (*Cytospora batata* Elliott). Occasional.

SEED-BED ROT (*Fusarium* sp.). Occasional.

Sycamore

ANTHRACNOSE (*Gnomonia veneta* (S. & S.) Kleb.). Very common; sometimes destructive in nurseries.

SUN SCALD. Several well defined cases. In some cases the trees died.

Tomatoes

LEAF BLIGHT (*Septoria lycopersici* Speg.). Abundant and very destructive (page 463).

FRUIT ROT (*Macrosporium solani* E. & M.). Common and very destructive.

ANTHRACNOSE (*Colletotrichum phomoides* (Sacc.) Chester). Abundant and very destructive.

STEM BLIGHT OR WILT (*Fusarium lycopersici* Sacc.). Abundant in one locality.

STREAK (Cause unknown). Very abundant in some fields in 1921.

MOSAIC Abundant.

LEAF MOLD (*Cladosporium fulvum* Ck.). Common in greenhouses and very severe.

LEAF ROLL (Cause unknown). Common and apparently becoming more serious.

Walnut

LEAF SPOT (*Marsonia juglandis* (Lib.) Sacc.). Abundant and cause of early fall of foliage.

BACTERIAL SPOT OF LEAF AND FRUIT (*Pseudomonas juglandis* Pierce). Abundant on English walnuts and the cause of many inquiries.

Watermelons

ANTHRACNOSE (*Colletotrichum lagenarium* (Passe.) E. & H.). Very abundant.

Wheat

RUST (*Puccinia coronata* Cda.). Common.

RUST (*Puccinia rubigovera* (De C.) Wint.). Common.

RUST (*Puccinia triticinia* Erh.). Common.

SMUT (*Tilletia fœtens* (B. & C.) Trel.). Common.

SMUT (*Tilletia tritici* (Bei.) Wint.). Common.

SMUT (*Ustilago tritici* (Pers.) Jens.). Common.

MOLD (*Cladosporium herbarium* (Pers.) Lk.). Abundant.

SCAB (*Gibberella saubinetti* (Mont.) Sacc.). Very common and destructive.

REPORT OF POTATO-SPRAYING TESTS

WILLIAM H. MARTIN

The cooperative potato-spraying tests were continued during the summer of 1920. In addition to the regular spray schedule a comparison was made of various strengths of Bordeaux mixture and the value of early and late applications of the standard 5-5-50 mixture.

Comparison of Various Strengths of Bordeaux Mixture

The soil on which this test was conducted is a Sassafras loam to sandy loam in excellent condition and well adapted to potatoes. The field was planted with home-grown Irish Cobblers. At the time of planting, 1 ton of a 4-8-3 fertilizer was applied per acre.

The purpose of this test was to compare the value of various amounts of copper for the control of tip-burn and early blight. The standard 5-5-50 mixture was compared with a 4-4-50 mixture. In both cases the sprays were applied at the rate of 100 gallons per acre. The sprayer used for this work was a traction machine, and a uniform pressure of 150 pounds was maintained for all of the work. The machine was equipped to spray 4 rows. Three nozzles were used to the row, one nozzle was directed downward while the other two were pointed inward, which plan gives a very good covering.

Five spray applications in all were made on the following dates. The first application was made on June 8 when the plants were 6 inches high. The second, third and fourth applications were made June 18 and 29, and July 9, respectively. Up until this time no foliage diseases of any kind had appeared on either the Bordeaux or the check plots. At the time of the fifth application, July 22, the plots receiving the copper sprays were still green, while the check plots were heavily infected with tip-burn and early blight. In this test the check plots were sprayed with arsenate of lead at the rate of 6 pounds of the powder per acre. In this connection the question might be raised as to whether this does not explain the relatively small increases resulting from previous spraying tests with Bordeaux mixture in New Jersey. There is little doubt but that if the check plots received the treatment given the general fields by a majority of the growers a greater difference would be observed between the so-called check plots and the treated plots. In most instances the New Jersey growers use an arsenate of lead or paris green dust for the control of insects; where the liquid is applied the pressure is usually very low and the machine is frequently equipped with but one nozzle to the row. As will be shown later in this report, thorough spraying with arsenate of lead can be expected to give an increase in yield over dusted plants and probably over those poorly sprayed.

In table 1 is given the arrangement of the plots together with the yield per acre for each plot. The last column of the table gives the number of dead leaves on the various plots on August 3. These data were obtained by making a count of the number of dead leaves on every tenth plant on the middle row of each plot.

The average yield of the plots sprayed with arsenate of lead is 260.3 bushels per acre as compared with 281.4 bushels and 266 bushels for the plots receiving the 5-5-50 and the 4-4-50 mixtures, respectively. On the basis of dead leaves from the count made August 3 there was also a difference in favor of the 5-5-50 mixture. The average number of dead leaves on the check plots was 93.3 per cent as compared with 70.3 per cent on the 5-5-50 plots and 76.3 per cent on the 4-4-50 plots.

Table 1

Comparison of Different Strengths of Bordeaux Mixture—Irish Cobbler Variety of Potatoes

TREATMENT	Total Yield per Acre	Calculated Yield per Acre of Checks	Difference	Dead Leaves on August 3
	bu.	bu.	bu.	per cent
Check— Arsenate of lead	279.5	.....	.....	92
Bordeaux mixture— 5-5-50 and arsenate of lead	283.4	269.2	+14.2	76
Bordeaux mixture— 4-4-50 and arsenate of lead	270.6	260.2	+10.4	76
Check— Arsenate of lead	250.6	.....	.....	93
Bordeaux mixture— 5-5-50 and arsenate of lead	273.9	255.2	+18.7	68
Bordeaux mixture— 4-4-50 and arsenate of lead	260.9	259.8	+ 1.1	77
Check— Arsenate of lead	264.6	.....	.....	93
Bordeaux mixture— 5-5-50 and arsenate of lead	288.2	259.1	+29.1	67
Bordeaux mixture— 4-4-50 and arsenate of lead	266.6	252.8	+13.8	76
Check— Arsenate of lead	246.5	.....	.....	98

These results were obtained in the absence of late blight; the increased yield as the result of spraying no doubt resulting from the control of tip-burn and early blight. Tip-burn was abundant and the difference in appearance between the plots sprayed with Bordeaux mixture and of those sprayed with arsenate of lead was greater than is indicated by the count of dead leaves.

From the results of this test, it is apparent that the use of 5-5-50 Bordeaux mixture can be expected to give better control of tip-burn and early blight than the 4-4-50 mixture.

Comparison of Early and Late Spray Applications

In the same field in which the work just reported was conducted a comparison was made of the relative value of early and late applications of Bordeaux mixture for the control of tip-burn and early blight.

The plots receiving the early applications were sprayed on June 8, 18 and 29, and those receiving the late applications on June 29 and July 9 and 22. The check plots were sprayed with arsenate of lead at the rate of 6 pounds of the powder to the acre.

The arrangement of the plots and the yield per acre are given in table 2. The average yield of the check plots was 259.4 bushels per acre, of the plots receiving the early applications 240.3 bushels per acre, and of those receiving the late applications 273.1 bushels per acre. It is apparent that the plots receiving the early applications showed a decrease of 19.1 bushels over the check plots, while those receiving the late applications showed an increase of 13.7 bushels.

As in the previous test a count of the dead leaves was made on August 3. At that time 98 per cent of the leaves on the check plots were dead, on the plots receiving the early applications 91 per cent of the leaves were dead, while on the plots receiving the late applications 75 per cent were dead.

It is interesting to compare the yield of these plots with that of the plots in the same field receiving 5 applications. The average yield of the check plots for these two tests was 260.3 bushels and 259.4 bushels, per acre, indicating that there was little difference in the soil in various parts of the field. The average yield of the plots sprayed five times with Bordeaux mixture was 281.4 bushels per acre, for those receiving the three late applications, 273.1 bushels and for those receiving the early applications 240.3 bushels per acre.

Table 2

Yield of Potatoes per Acre in Comparison of Early and Late Spray Applications, Irish Cobbler Variety

TREATMENT	Series A	Series B	Series C	Average
	bu.	bu.	bu.	bu.
Check—Arsenate of lead	242.3	249.2	245.6	245.7
Bordeaux mixture and arsenate of lead, June 8, 18, 29.............	241.3	239.3	240.4	240.3
Bordeaux mixture and arsenate of lead, June 29, July 9............	305.4	278.3	268.4	284.0
Check—Arsenate of lead	290.3	272.9	256.3	273.1

The results of this test indicate the importance of the late applications. The superiority of the late applications no doubt arose from the fact that in this test no early blight appeared until late in the season. The early applications were no doubt washed from the leaves before the disease became prevalent, and consequently afforded little protection. On the other hand, the late applications covered the leaves with a protective film of the copper spray at a time when needed for the protection of the plant. The difference in yield between the plots sprayed three times late in the season and those sprayed five times would indicate further that it may not be essential that the early applications be made. This would lead to a considerable reduction in spraying cost, but must be the subject of further study before definite recommendations can be made.

Table 3

Arrangement of Plots and Yield per Acre of Spraying Tests with Late-Crop Irish Cobblers

TREATMENT	Total Yield per Acre	Calculated Yield per Acre of Check	Difference	Dead Leaves on October 18
	bu.	bu.	bu.	per cent
Check	166.6	.....	.....	90
Bordeaux mixture 5-5-50	202.6	165.4	37.2	15
Arsenate of lead	172.2	164.2	8.0	75
Check	163.0	.....	.....	95
Bordeaux mixture 5-5-50	193.0	162.7	30.3	5
Arsenate of lead	178.2	162.5	15.7	70
Check	162.3	.....	.....	95
Bordeaux mixture 5-5-50	202.3	.....	.....	7

Spraying Tests with the Late Crop

Spraying tests with the late crop were conducted with both the American Giant and the Irish Cobbler varieties. In previous spraying tests with the former variety, planted in the spring, conflicting results have been secured. This year a spraying test was conducted with this variety grown late for seed purposes to determine if positive results would follow. The purposes of the test was defeated, however, in that late blight made its appearance, thus ensuring the success of the spray treatment.

Irish Cobbler Variety

The soil on which this test was conducted is a Sassafras loam in good condition. One ton of a 4-8-3 fertilizer was applied at time of planting. There were 15 plots in all, a check plot alternating between each two treated plots. As a result of the fact that there were no insects present in the field, the check plots were left without any kind of spray treatment.

The spray mixtures used were the standard 5-5-50 Bordeaux applied at the rate of 100 gallons per acre and arsenate of lead used at the rate of 6 pounds per acre. The latter material was included in the test to determine if thorough spraying with arsenate of lead would lead to increased yields over plots that had not been sprayed.

Five spray applications were made in all on the following dates, September 8, 12 and 27, and October 7 and 18. The last of September late blight was found on the unsprayed plots and by October 18 most of the leaves were dead. At that time a count was made of the number of dead leaves on each plot. On the unsprayed checks 94 per cent were dead as compared with 27 per cent on the plots sprayed with Bordeaux mixture, and 68 per cent on those sprayed with arsenate of lead.

The arrangement of the plots as well as the yield per acre is given in table 3. Unfortunately the third repeat of the arsenate of lead treatment and the last check plot was harvested before the weights could be obtained. The average yield of the unsprayed plots was 163.9 bushels per acre, of the arsenate of lead plots 175.2 bushels, and of the Bordeaux plots 199.3 bushels per acre. It will be seen that the arsenate of lead plots showed an increase of 11.3 bushels per acre over the unsprayed plots.

American Giant Variety

This test was conducted in the same field as was the one with the Irish Cobbler variety. The spray mixture used was the standard 5-5-50 Bordeaux mixture applied at the rate of 100 gallons per acre. The number of applications and the dates on which they were made were the same as for the Irish Cobbler variety.

Early in October late blight was responsible for killing the leaves. On October 18 a count was made of the number of dead leaves on each plot. On the unsprayed check plots 62 per cent were dead as compared with 12 per cent on the plots sprayed with Bordeaux mixture. The average yield of the check plots was 150.4 bushels per acre as compared with 178 bushels for the plots sprayed with Bordeaux mixture (table 4).

Table 4

Arrangement of Plots and Yield per Acre of Spraying Test with the Late Crop (American Giant Variety)

TREATMENT	Total Yield per Acre	Rotted Tubers at Time of Digging	Yield of Sound Tubers	Calculated Yield per Acre of Checks	Difference
	bu.	bu.	bu.	bu.	bu.
Check	163.0	2.4	161.6	.....	....
Bordeaux mixture 5-5-50..	184.0	.....	184.0	156.7	27.3
Bordeaux mixture 5-5-50..	199.4	.....	199.4	151.8	47.6
Check	153.1	6.2	146.9	.....	....
Bordeaux mixture 5-5-50..	166.9	.....	166.9	141.5	25.4
Bordeaux mixture 5-5-50..	161.7	.....	161.7	136.1	25.6
Check	135.3	4.6	130.7	.....	....

THE INFLUENCE OF SULFUR ON THE CONTROL OF POTATO SCAB

WILLIAM H. MARTIN

The studies resumed last year on the relation of sulfur to the control of common scab of potatoes have been continued. Experiments were conducted in the important potato-growing sections of the state on different soil types and with both American Giant and Irish Cobblers varieties. In all of the tests conducted the sulfur applications were made broadcast just before the crop was planted. The applications were made by hand or with a grain drill. The latter method proved more efficient, since a uniform distribution is assured and the sulfur is thoroughly worked into the soil.

In the experiments conducted no differences were apparent in vine growth on the plots receiving various amounts of sulfur. When the crop was harvested it was divided into three classes, namely, clean, salable and unsalable scabby. The first class consisted of all tubers free from scab. The tubers in the second class showed only a moderate infection, while those in the last class were for most part covered with scab lesions.

Soil samples were taken at the time of planting and again when the crop was harvested. The hydrogen-ion concentration of water extracts of the soil samples was determined colorometrically following the method devised by Gillespie (2). The indicators used were those recommended by Clark and Lubs (1).

This work will be reported briefly here; a more complete discussion of the results will appear in another place. The following tables show the yield per acre as well as the relation of clean, salable and unsalable scabby tubers to the hydrogen-ion exponent. The data given are averages obtained from at least three replications of each treatment and of four checks plots.

Irish Cobbler Variety

Experiment 1

The soil on which this experiment was conducted is a very light sandy loam. In 1919 the field was planted with the Red Skin variety of potatoes. At that time the entire crop was very scabby, a greater part of the tubers being unsalable. Sulfur applications at the rate of 300 and 600 pounds per acre were made on April 27, just before planting. The effect of the sulfur treatment on total yield and control of scab is shown in table 1.

Table 1

Influence of Sulfur Applications on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(I. Kaufmann farm, Bridgeton)

Treatment	Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check*	97.3	20.1	40.8	38.5	6.05
300 lbs. Sulfur†...	88.2	54.1	24.5	21.4	5.50
600 lbs. Sulfur†...	87.2	75.0	20.8	4.2	4.75

*Average of 6 plots.
†Average of 3 plots.

It will be seen from the table that the 300 and 600-pound applications show a decrease in yield of 9.1 and 10.1 bushels per acre over the adjoining check plots. It will also be seen that there was a marked gain in the number of clean tubers on the treated plots, this increase amounting to 34 and 54.9 per cent for the 300 and 600-pound applications, respectively. On the basis of unsalable scabby tubers there was a considerable decrease on the sulfured plots, the decrease being greater with the heavier applications. With the decrease in the number of unsalable scabby tubers there was a corresponding decrease in the exponent values of the soil extracts from the treated plots. At the time of planting the exponent value of the check plots was 6.3 as compared with 6.05 at the time of harvesting. The exponents of the plots receiving the 300 and 600-pound applications were 5.50 and 4.75, respectively.

Experiment 2

The soil on which this experiment was conducted is a Sassafras to sandy loam. This field was limed in 1916. Since then it has been in corn in 1916, potatoes in 1917 and 1918 and corn in 1919. In 1918 the potato crop was very scabby, approximately 30 per cent of the crop being unsalable.

Sulfur flour was applied at the rate of 300 and 600 pounds per acre just before planting. Soil samples taken from the various plots before the sulfur applications were made showed an average hydrogen-ion exponent of 6.6.

Table 2

Influence of Sulfur Applications on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(Alfred Sloan farm, Elmer)

Treatment	Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check*	254.0	61.2	38.8	....	5.96
300 lbs. Sulfur†...	238.8	92.3	7.7	....	4.85
600 lbs. Sulfur†...	258.9	92.2	7.8	....	4.56

*Average of 6 plots.
†Average of 3 plots.

The results of this experiment are given in table 2. On the basis of total yield the plots receiving 300 pounds of sulfur per acre show an apparent decrease of 15.2 bushels over the untreated plots, while those receiving the 600-pound application show an increase of 4.9 bushels.

In this experiment there were no unsalable scabby potatoes. There was, however, a marked increase in the number of clean tubers on the plots receiving the sulfur applications, this increase being slightly greater for the plots receiving the 300-pound application. There is little difference in exponent values between the treated plots; 4.85 and 4.56 for the 300 and 600-pound applications, respectively. It is apparent from the results obtained that for this soil it was unnecessary to use sulfur in excess of 300 pounds to obtain satisfactory control of scab.

Experiment 3

The soil on which this test was conducted is a sandy loam. The field received an application of lime in 1913 at the rate of ½ ton of calcium oxide per acre. It was last planted in potatoes in 1917 and at that time there was a severe infestation of scab over the entire field. Sulfur was applied at the rate of 300 and 600 pounds per acre just before planting.

Table 3

Influence of Sulfur Applications on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(Isaac Bacon farm, Salem)

Treatment	Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check*	287.3	23.5	32.7	43.8	6.15
300 lbs. per acre†..	291.3	64.8	17.4	17.8	6.1
600 lbs. per acre†..	328.3	68.0	20.1	11.9	4.8

*Average of 6 plots.
†Average of 3 plots.

The results of this test are given in table 3. It will be seen that both the 300 and 600-pound applications gave increased yields over the check plots. As in the preceding experiments there was a considerable increase in the number of clean tubers with a corresponding decrease in the unsalable scabby tubers on the treated plots.

The initial hydrogen-ion exponent of this soil was 6.4 as compared with 6.15 for the check plots at the time of digging. It will be observed that a marked decrease in exponent values resulted on the plots treated with 600 pounds of sulfur, while the decrease on the plots receiving 300 pounds was very slight. It has been previously shown (3) that the hydrogen-ion exponent values reach their lowest level about mid-season and then tend to return to the original values at digging time. This may possibly account for the fact that while there is no apparent lowering of exponent values on the plots receiving the 300-pound application the control of scab is approximately as efficient as on the plots treated with 600 pounds of sulfur.

Experiments with the American Giant Variety

In the past the New Jersey growers have frequently resorted to growing the American Giant variety, resulting from the fact that they were considered less likely to scab than the Irish Cobbler variety. It is doubtful if this is longer true, since many fields were observed the past several years in which the American Giant variety grew very scabby. A number of experiments were conducted with this variety this year.

Experiment 1

The field in which this work was conducted received an application of 1,700 pounds of ground limestone per acre in 1913. It was last in potatoes in 1915. At that time there was a uniform scab infection over the entire field, approximately 30 per cent of the crop being unsalable. Sulfur was applied at the rate of 300 and 600 pounds per acre just before planting.

Table 4

Influence of Sulfur Applications on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(Wm. Patterson farm, Freehold)

Treatment	Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check*	308.8	39.9	47.9	12.2	6.22
300 lbs. Sulfur†...	269.7	76.9	16.5	6.6	5.86
600 lbs. Sulfur†...	316.8	90.3	9.4	0.3	4.8

*Average of 6 plots.
†Average of 4 plots.

The results of the test are given in table 4. On the basis of total yield the plots receiving the 600-pound application showed an increase of 8.0 bushels per acre over the check plots, while those receiving 300 pounds showed a decrease of 39.1 bushels. In view of the fact that the 600-pound application resulted in a slight increase it is questionable if the decrease resulting from the 300-pound application can be attributed to any injurious effect of the sulfur treatment.

Of the total yield from the untreated plots 60.1 per cent were scabby, while the plots treated with 300 pounds of sulfur and those receiving 600 pounds gave total yields of which only 23.1 per cent and 9.7 per cent, respectively, were scabby. The initial exponent of this soil was 6.4 as compared with an exponent of 6.2 at time of digging. It will be seen that with increased applications of sulfur there were corresponding decreases in exponent values, amounting to 0.36 for the 300, and 1.42 for the 600-pound treatment.

Experiment II

This field received 2,000 pounds of hydrated lime per acre in 1916. It was last in potatoes in 1918 and 1919. At that time, while there was considerable scab, the infestation was not uniform. Sulfur applications were made at the rate of 300 and 600 pounds per acre. The results are given in table 5.

Table 5

Influence of Sulfur Applications on Total Yield and Percentage of Scabby Tubers

(I. Van Deveer farm, Freehold)

Treatment	Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby
	bu.	per cent	per cent	per cent
Check*	330.5	44.4	52.4	3.2
300 lbs. Sulfur†	311.6	73.9	23.2	2.9
600 lbs. Sulfur†	350.8	76.8	22.1	1.1

*Average of 4 plots.
†Average of 2 plots.

In this field the plots receiving both the 300 and the 600-pound treatment outyielded the adjoining untreated plots. While the number of clean tubers is increased on the treated plots as compared with the checks, with a corresponding decrease in the number of unsalable tubers, the differences are by no means as great as recorded for the first experiment with this variety. This may possibly be accounted for by the fact that the decrease in exponent values is not as great in this as in the other experiment, being only 0.2 and 0.4 for the 300 and 600-pound applications, respectively. This slight decrease in exponent values might be accounted for by the fact that the sulfur was not oxidized due to the absence of sulfur-oxidizing organisms. The importance of their presence to insure success following the use of sulfur for the control of scab will be discussed at another place in this report.

Experiment 3

This field received an application of lime in 1902 and a heavy application of marl in 1904. It was last planted in potatoes in 1917. At that time there was a uniform infestation of scab on the portion of the field treated with marl. Sulfur was applied at the rate of 300 and 600 pounds per acre. The results are given in tables 6.

Table 6

Influence of Sulfur Applications on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(Britton Cook farm, Farmingdale)

Treatment	Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check*	159.8	12.0	57.8	30.2	6.3
300 lbs. Sulfur†...	182.0	34.6	46.8	18.6	6.1
600 lbs. Sulfur†...	170.2	40.8	45.5	13.7	5.9

*Average of 6 plots.
†Average of 4 plots.

The plots receiving the light application of sulfur showed a decrease of 18.9 bushels per acre, while the 600-pound treatment showed an increase of 20.3 bushels over the check plots. The number of clean tubers was increased from 44.4 per cent on the untreated plots to 73.9 per cent on the plots receiving 300 pounds of sulfur, and 76.8 per cent on those receiving 600 pounds. There was a corresponding decrease in the number of scabby tubers.

References

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(2) Gillespie, L. J., 1920. Colorimetric determination of hydrogen-ion concentration without buffer mixtures, with especial reference to soils. *In* Soil Sci., v. 9., no. 2, p. 115-136.

(3) Martin, Wm. M. H., 1921. A comparison of inoculated and uninoculated sulfur for the control of potato scab. *In* Soil Sci., v. II, no. 1, p. 75-84.

INOCULATED VS. UNINOCULATED SULFUR FOR THE CONTROL OF POTATO SCAB

William H. Martin

It will be seen from the preceding paper that while the use of commercial sulfur flour in most of the tests conducted gave very good control of scab, in others the differences in the number of salable potatoes on the treated and untreated plots was not so marked. It has been demonstrated that the biological factor is influential in the oxidation of sulfur. In view of the fact that the beneficial action from the use of sulfur results from its oxidation, the importance of the presence of sulfur-oxidizing organisms is readily apparent. It is very probable that the lack of these organisms in the soil might determine to a large extent the success or failure of sulfur to control scab. The experiments herein reported were conducted to determine to what extent this might be true.

In this work inoculated and uninoculated commercial sulfur flour were used. Inoculation was effected by means of a thorough mixing of the commercial flour with 1 per cent of soil from a compost heap known to be well supplied with the sulfur oxidizing organism. The sulfur applications were made with a grain drill just after harrowing and just before planting. The experiments were conducted with the Irish Cobbler variety. At the time of harvesting, soil samples were taken and the crop divided into classes as previously outlined.

The results of the test are given in the following tables. The data included in the tables show the yield per acre as well as the relation of clean, salable and unsalable scabby tubers to the hydrogen-ion exponent.

Experiment 1

The soil on which this experiment was conducted is a Sassafras loam. In 1915 an application of ground limestone was made at the rate of 3 tons per acre. Following this treatment the field was in grass in 1916 and 1917, and in potatoes in 1918 and 1919. In the latter year there was a uniform infestation of scab over the entire field, a great part of the crop being unsalable.

Both inoculated and uninoculated sulfur were applied just before planting at the rate of 300 and 600 pounds per acre. It will be seen from table 1 that on the basis of total yield the treated plots showed a considerable increase over the untreated check plots.

Table 1

Influence of Applications of Inoculated and Uninoculated Sulfur on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(R. E. Colyer farm, Jamesburg)

Treatment	Total Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check	195.0	0	6.4	93.6	7.06
600 lbs. uninoculated sulfur	229.0	10.9	37.7	51.4	6.23
600 lbs. inoculated sulfur	249.4	46.9	28.7	24.4	5.60

This increase may be accounted for in part by the fact that the tubers on the check plots were severely scabbed, none of them being free from scab lesions. On the other hand, while of those from the treated plots some were scabby, none were severely infected.

With the 600-pound applications of both the inoculated and the uninoculated sulfur there was a considerable decrease in unsalable potatoes over the adjoining check plots. This decrease amounted to 69.2 for the former and 42.2 for the latter. The benefit derived from the use of the inoculated sulfur is more clearly brought out when the number of clean tubers is considered. On the untreated plots none were clean as compared with 10.9 per cent for the plots treated with the uninoculated, and 46.9 per cent for those receiving the inoculated sulfur.

The plots receiving the inoculated sulfur showed a greater decrease in hydrogen-ion exponent values than those treated with the uninoculated sulfur. This decrease amounted to 1.45 for the former and 0.83 for the latter.

The plots treated with 300 pounds of sulfur likewise show a lower percentage of scabby tubers than the untreated plots. Of the total yield from the untreated plots, 58.3 per cent were unsalable scabby while the plots treated with inoculated and uninoculated sulfur gave a total yield of which 29.4 per cent and 57.4 per cent, respectively, were unsalable.

Table 2

Influence of Applications of Inoculated and Uninoculated Sulfur on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(R. E. Colyer farm, Jamesburg)

Treatment	Total Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check*	183.1	9.4	32.3	58.3	6.6
300 lbs. uninoculated sulfur*	254.3	13.1	29.5	57.4	6.3
300 lbs. inoculated sulfur*	288.7	34.1	36.5	29.4	6.0

*Average of 3 plots.

From the table it will be seen that the plots receiving 300 pounds of inoculated sulfur showed greater decreases in exponent values than those receiving the uninoculated sulfur.

It is interesting to note that the decrease in exponent values indicated for the plots treated with 300 pounds of inoculated sulfur was nearly as large as for the plots treated with 600 pounds of uninoculated sulfur. The latter showed a reduction of 42 per cent in the number of unsalable scabby potatoes as compared with 28.9 per cent for the former, a difference of only 13.3 per cent in favor of the heavier applications.

Experiment 2

The soil on which this experiment was conducted is a Penn loam that had not been planted in potatoes for a number of years. To insure the presence of the scab organism in the soil untreated scabby seed was planted. Sulfur at the rate of 900 pounds per acre was broadcasted by hand just before planting. The results are given in table 3.

Table 3

Influence of Applications of Inoculated and Uninoculated Sulfur on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(College farm, New Brunswick)

Treatment	Total Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check	78.0	43.2	34.4	22.4	6.6
900 lbs. uninoculated sulfur	60.2	69.3	15.4	15.3	4.6
900 lbs. inoculated sulfur	78.2	81.4	17.1	1.5	4.7

On the basis of total yield there was only small difference between the check and the treated plots. As in the preceding experiments there was a marked reduction of unsalable scabby tubers on the plots treated with inoculated sulfur with a much smaller reduction on the plots treated with the uninoculated sulfur. The increase in the percentage of clean potatoes was likewise greater for the inoculated sulfur, amounting to 38.2 per cent as compared with 26.1 per cent for the uninoculated sulfur.

Soil samples taken before the sulfur applications were made showed a mean value for all of the determinations of 6.61. The exponent of the check plots at time of harvesting was 6.6. The values of the hydrogen-ion exponents of the soil samples corresponding to the two treatments show a considerable decrease over those of the check plots, being 4.6 for the plots receiving the uninoculated sulfur and 4.7 for those treated with the inoculated sulfur. While the exponent values for the two treatments are approximately identical, it will be seen from the table that the number of unsalable tubers was reduced from 15.3 per cent recorded for the plots treated with uninoculated sulfur to 1.5 per cent for those receiving the inoculated sulfur.

THE FERTILIZER VALUE OF SULFUR FOR POTATOES

WILLIAM H. MARTIN

Conflicting results have been secured in the field regarding the effect of sulfur applications on the yield of potatoes. In some of the tests, plots receiving as many as 600 pounds of sulfur per acre showed marked increases over adjoining untreated check plots. In other cases an application of 300 pounds per acre resulted in decreased yields. In order that more definite information might be had on this question, experiments were conducted in the greenhouse during the winter of 1919-20. The original plan of this work was to study the effect of sulfur treatments on both scab control and yield. The soil on which the work was conducted proved too acid, however, to allow for the development of the scab organism. For this reason the experiment was limited to a test of the effect on yield.

In this work two methods of applying the sulfur were adopted. In one case it was broadcasted and thoroughly worked into the surface soil just before planting. Three amounts were applied in this manner, namely, 200, 400 and 600 pounds per acre. The second method consisted of mixing sulfur with the fertilizer. Applications were made at the rate of 100, 200 and 300 pounds per acre.

The floor of the greenhouse in which this work was conducted was divided by cement partitions into 28 compartments, each 3 feet deep and containing 7.5 square feet Seven series were included in the experiment. Each series consisted of a check plot with three treated plots. To eliminate, as far as possible, any differences that might arise from variation in the size of the seed-piece and in the yielding power of different tubers, each seed potato was cut into four equal pieces, the cut being made through the stem and bud end. One of the quarters was then planted in each of the four plots of a series. In case of the broadcasting method each series was repeated four times while there were three repeats of the sulfur-fertilizer mixture.

Each of the 28 plots received a uniform application of a 4-8-3 fertilizer at the rate of 1,800 pounds per acre. Half of the ammonia was derived from nitrate of soda, and the remaining half from ammonium sulfate. The phosphorus and potash were derived from phosphoric acid and muriate of potash.

The moisture content of the various plots was maintained as nearly uniform as possible. Before the sulfur applications were made and again at weekly intervals until the crop was dug, soil samples were taken and the hydrogen-ion concentration of soil extracts determined colorimetrically.

The effect of the two methods of applying the sulfur on yield and hydrogen-ion concentration is given in the tables following.

Sulfur in Combination with the Fertilizer

The effect of mixing sulfur with the fertilizer on yield and exponent values is given in table 1. It will be seen from the table that the addition of 100 pounds of sulfur to the fertilizer had no injurious effect, the yield of these plots being 3.4 bushels more than that of the check plots. The addition of 300 pounds of sulfur to the fertilizer brought about a decrease of 18.7 bushels over the check plots. A still greater difference, amounting to 75.3 bushels per acre, resulted from the fertilizer mixture containing 500 pounds of sulfur. It is apparent from the results secured that while a fertilizer mixture containing 100 pounds of sulfur can be used without danger of injuring the crop, any amount in excess of that can be expected to lead to a reduced yield.

Table 1

Effect of Sulfur in the Fertilizer on Yield and Hydrogen-ion Concentration

Treatment	Yield per Acre*	Hydrogen-ion Concentration		
		When Planted Dec. 2	When Dug May 4	Difference
	bu.	pH	pH	pH
Check	285.8	5.0	5.1	+0.1
100 lbs. sulfur in the fertilizer	289.2	5.1	4.8	—0.3
300 lbs. sulfur in the fertilizer	267.1	5.6	4.9	—0.7
500 lbs. sulfur in the fertilizer	213.5	5.53	4.7	—0.83

* Average of 3 plots.

From table 1 it will be seen that the original hydrogen-ion exponent values of soil samples from the various plots included in this test were low. The initial exponent value of the check plots was 5.0 as compared with 5.1 at digging time. It will be seen from the table that with increased amounts of sulfur there were corresponding decreases in the exponent values, the greatest decrease, 0.83, resulting from the use of 500 pounds of sulfur. It will be observed also that, with the exception of the 100-pound treatment, with a decrease in exponent values below that of the check plots, there was a corresponding decrease in yield.

Sulfur Broadcasted Before Planting

The effect of broadcasting sulfur on total yield and hydrogen-ion concentration is shown in table 2. It will be seen that the 200 and 300-pound applications gave slightly increased yields over the check plots. These increases, amounting to 4.2 and 1.9 bushels, are so small, however, as to be well within experimental error so that no statement can be made as to the beneficial effect of the sulfur. It is evident, however, that for the conditions under which this work was conducted an application of 200 and 400 pounds of sulfur produced no injurious effects. The yield of the plots receiving 600 pounds of sulfur, on the other hand, was 6.5 bushels less than that of the check plots.

Table 2

Effect of Sulfur Broadcasted on the Yield of Tubers and on Hydrogen-ion Concentration

Treatment	Yield per Acre	Hydrogen-ion Concentration		
		When Planted Dec. 2	When Dug May 4	Difference
	bu.	pH	pH	pH
Check	255.9	4.82	4.8	—0.02
200 lbs. sulfur broadcasted	260.1	4.65	4.6	—0.05
400 lbs. sulfur broadcasted	257.8	4.67	4.4	—0.27
600 lbs. sulfur broadcasted	249.4	5.0	4.4	—0.60

From table 2 it will be seen that the initial pH value of soil samples from the check plots was 4.82 as compared with 4.8 at the time of digging. The plots receiving the 200 and 400-pound applications showed very little change in exponent values. The largest decrease resulted from the 600-pound application. It is interesting to note in this connection that the decrease in exponent values resulting from broadcasting 600 pounds of sulfur is 0.6 as compared with a decrease of 0.7 recorded for the plots receiving 300 pounds of sulfur mixed with the fertilizer. This possibly accounts for the fact that in some of the early experiments a reduction in yield followed the use of sulfur for the control of scab. In some of these earlier tests sulfur was applied at the rate of 600 pounds per acre in the row. Applied in this way the acidity produced would be so great as to interfere with the proper development of the potato crop.

STUDIES OF THE RELATION OF MATURITY TO VIGOR IN SEED POTATOES

WILLIAM H. MARTIN

The successful potato grower of today realizes the importance of planting only vigorous seed in order that maximum yields may result. This demand on the part of the grower for high-grade seed has resulted in the establishment of seed-potato certification in many of the important seed-growing sections. The purchase of seed potatoes certified to be relatively free from disease goes a long way toward solving the problem of securing the best seed. Freedom from disease alone is not sufficient, however, to insure tubers of highest vigor. The question of maturity is one of considerable importance, since it has been frequently demonstrated that immature tubers possess more vitality than mature tubers and consequently are more desirable for seed purposes.

As early as 1849 Wilson (4) stated, "Green tubers, or tubers which have never ripened to dryness, are, in all circumstances, the best." Sweet (3) states that the remark is made of Sir Matthew Wallace, a prominent English potato grower, that, "he is without exception using partially grown or partially mature seed. The potates that are lifted in July are kept over until the next March for planting. He claims that he gets less disease than when lifted at maturity, the potato throws out a less number of sprouts when planted, it makes a more vigorous growth and the sprout is stronger. Consequently, the crop ripens earlier." The Department of Agriculture of Ireland likewise points out that "seed potatoes from crops lifted before they fully mature will produce more vigorous plants, and, consequently, heavier yields than seeds from crops which have become mature."

In a series of experiments conducted at Wye and at the Midland Agriculture College, Hutchison (1) demonstrated the advantage of immature over mature tubers for seed. He states that the superiority of immature tubers may be due to four causes; (a) the method of selection, (b) the structure of the tuber coats, (c) the amount and condition of the reserve food materials and (d) the length of the time in storage. Hutchison suggests that the best practice to follow in obtaining immature seed is to plant at the usual time of the year and raise the crop early rather than plant in the late summer or early fall.

Macoun (2) planted potatoes at 14-day intervals starting May 22, the last planting being made July 3. The tubers from the various lots were planted on the same date the following year. In most every instance there was an increase in yield from the earliest to the latest plantings, indicating that the most immature seed could be expected to give the largest yield. In another test he harvested seed immature from an early planted crop. The following year this immature seed gave pronounced increases in yield when compared with mature seed of the same variety.

In New Jersey two methods of obtaining seed potatoes are commonly followed. The first, and more important, consists in planting not earlier than July 15 and not later than August 20. By planting at this time of the year the vines are usually growing vigorously when killed by frost, thus ensuring seed that has not matured. Among the local growers the last planted is considered the best for seed, probably resulting from the fact that this seed is more immature than seed from the earliest plantings. The second method consists of harvesting tubers immature from the main crop while the vines are still green. In the past it has not been definitely known at what stage in the development of the plant this should be done in order to obtain seed of the highest vigor. The studies here reported were undertaken with the idea of determining if possible the best time to harvest tubers from the main crop for seed purposes as well as to determine the relation between mature and immature seed with regard to vigor.

Experimental Procedure

In 1919 an area of 1/20 acre was planted with the Irish Cobbler variety to serve as a seed plot. The seed used for planting this plot was selected for uniformity and freedom from disease in 1918. The plants in the seed plot made a vigorous growth and were free from disease. At weekly intervals beginning two weeks after blossoming and continuing until the tops were dead, 15 hills were harvested. The hills harvested were selected for uniformity as to both size and appearance, especially with regard to the maturity of the vines. As each lot was harvested the weight of the individual hills was obtained. They were then placed in a well ventilated cellar until fall when they were removed to a cold-storage plant. The dates on which the various lots were dug, together with the yields per acre and the condition of the tops at the time of digging are given in table 1.

Table 1

Yield of Cobblers Dug at Intervals During the Period of Development

Date of Digging 1919	Yield per Acre	Condition of Plants
	bu.	
July 9	124.9	Two weeks after blossoming
July 17	156.5	Plants green, vigorous
July 24	207.4	24 per cent of the leaves dead
July 31	258.3	50.4 per cent of the leaves dead
August 8	281.3	91.5 per cent of leaves dead. Stems still green
August 16	280.9	Leaves and stems dead

It will be seen from the table that in a 37-day period, over which the work was conducted, there was a gain of 156 bushels per acre in total yield. The greatest weekly increases were noted for July 17-24 and for July 24-31, a gain of 50.9 bushels resulting in each of these time periods. It will be observed also that this period of greatest tuber development occurred between the time the tops began to die and when 50 per cent of the leaf surface was dead. It is interesting to note that in the time period from August 8 to August 16, that is, from the time 91.5 per cent of the leaves were dead until the stems and leaves were dead there was no increase in tuber development.

In the spring of 1920 the seed was removed from the storage house and treated for 1 hour in a solution of mercuric chloride made up at the rate of 4 ounces of the crystals to 30 gallons of water. When the seed had dried it was cut into uniform pieces, each weighing 1 ounce. In so far as possible the number of eyes was kept uniform on the various seed-pieces. The soil on which this experiment was conducted is a Penn loam. At the time of planting, April 20, an application of 1,800 pounds of a 4-8-3 fertilizer was made in the row. A plot consisted of 20 hills and to eliminate as far as possible the error arising from the use of a plot this small, each treatment was repeated six times.

While there were no marked differences in the time of germination of the various plantings, the immature tubers tended to be slightly ahead of those that were mature. As the season advanced, marked differences became apparent in the size and general vigor of the plants on the various plots.

Table 2

Height of the Vines in 1920 and Rainfall in 1919

Date Dug, 1919	Series 1	Series 2	Series 3	Series 4	Series 5	Series 6	Average	Rainfall, 1919
	in.	in.	in.	in.	in.	in.	in.	in.
July 9	12.5	12.7	12.9	12.9	13.3	13.0	12.9	July 2-9 1.25
July 17	10.1	10.5	11.8	11.0	10.8	12.6	11.1	July 10-17 1.83
July 24	13.0	13.2	13.4	11.7	12.8	10.6	12.4	July 18-24 5.02
July 31	11.7	11.9	11.9	12.0	10.9	11.2	11.6	July 25-31 0.23
August 8	10.7	11.1	11.2	10.0	11.1	10.9	10.8	July 31-Aug. 8 0.39
August 16	9.8	9.1	10.1	9.6	9.2	9.6	9.6	Aug. 9-Aug. 16 2.75

On June 14 the measurement of each plant was obtained. The average for each of the six plots is given in table 2.

It will be seen from the table that with the exception of the seed dug on July 24, 1919, there was a fairly uniform decrease in the height of the vines with increased maturity in the seed-piece. The average of the six duplications is given in the second to the last column of the table. It will be observed that the vines from the seed dug July 17 are smaller than those from seed dug a week later, the average height being 11.1 and 12.4 inches, respectively.

In this connection it is interesting to examine the precipitation records for 1919 for the time periods during which the seed was dug. These data are included in the last column of table 2. For the period July 2-9 and July 10-17 there was a rainfall of 1.25 and 1.83 inches, respectively, as compared with 5.02 inches for the period from July 18 to 24; of this amount, 3.25 inches fell the first three days. This excessive rainfall, coming at a time when tuber development was at its maximum, doubtless led to a rapid soft growth of the tuber so that the texture of the cortical layer was probably as immature as was that of the tubers dug July 9. This fact may possibly account for the differences noted in vine growth in 1920. This is in accordance with the view expressed by Hutchison (1). In explaining the superiority of immature over mature seed he states that, "the contex of immature tubers is thinner, less firmly attached and capable of being more easily ruptured than that of mature tubers. The character of the tuber coat varies with different varieties, and also in the same variety when grown under different conditions of soil and climate. Warm, dry soils favor this development and tubers grown on such land are unsuitable for seed."

These differences in the appearance of the vines of the various plots were maintained throughout the growing season.

Table 3 gives the average yield of the various plots, including primes and seconds as well as the total yields.

Table 3

Relation of Immature Seed to Yield and to Percentage of Primes

Date dug in 1919	Primes per Acre	Seconds per Acre	Total Yield per Acre	Proportion of Primes
	bu.	bu.	bu.	per cent
July 9	222.6	48.2	270.8	82.2
July 17	207.6	52.3	259.9	79.8
July 24	192.6	57.1	249.7	77.1
July 31	189.4	53.9	243.3	77.7
August 8	165.4	50.4	215.8	76.6
August 16	156.2	43.8	196.4	77.7

On the basis of total yield the greatest returns were had from the plots planted with immature seed. With each increase in maturity there was a corresponding decrease in yield, the lowest yield being recorded on those plots planted with seed that had matured before being dug. Between the most immature seed, dug July 9, and that dug August 16, when the vines had died, there was a difference of 74.4 bushels per acre. The yield of the plots from tubers dug July 24 was not as great as from those dug July 17, despite the fact that vines on the former plots were larger than those on the latter.

Except for the plots planted with the most immature seed there was little variation in the number of second-prize tubers. The former plots gave a total yield of which 82.2 per cent were primes as compared with 79.8 per cent for the seed dug July 17. Of the remaining plots those planted with seed dug July 24 and 31 showed 77.1 and 77.7 per cent, respectively.

From the results of the studies here presented it is apparent that the more immature the seed the greater will be the yield of marketable potatoes. It is questionable if the use of tubers from plants that have matured or which have died prematurely for seed purposes will give satisfactory results. In selecting tubers to be used for seed they should not only be free from disease but should be immature. Disease-free plants of low vigor cannot produce a maximum crop.

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CELERY DISEASE INVESTIGATIONS

R. F. POOLE

This department has been investigating the cause and methods of control of celery root rots on muck soil areas of Bergen County for a number of years. Losses, due to *Bacillus carotovorus, Sclerotinia libertiana,* and nematodes have been very severe, especially when infected soil was cropped with Golden Self-Blanching varieties of celery. The heaviest losses occur under high temperature and moisture conditions, which are favorable for the development of these organisms. Green varieties are not severely attacked by *Bacillus carotovorus.* All varieties are susceptible to *Sclerotinia libertiana.*

Two methods of controlling root-rot diseases have been pursued in the field: application of chemical compounds as soil disinfectants and selecting for disease-resistant Golden Self-Blanching celery varieties. High-priced chemicals in the past few years made it necessary to discontinue the former part of our investigations. A very good supply of celery seed was produced last year from plants, which seemed to be resistant to *Bacillus carotovorus.* The plants were transplanted in the greenhouse from a muck farm. The seed is being tested this year on the infected muck soils.

Damping-off of seedling celery plants of all varieties in greenhouses has caused heavy losses, where plants were being grown for April and May plantings. This trouble is due to the well known fungus, *Sclerotinia libertiana,* which causes lettuce drop and damping-off of many other vegetables and plants. Rotating celery and lettuce has spread this fungus on cultivated areas. The temperature and moisture conditions of greenhouses are ideal during early spring for the development of this fungus. Several thousand plants are sometimes destroyed in a few days. The disease is first observed as a wet, soft rot near the ground. The plants later fall over, and a flocculent white mass of the fungus will appear on the leaves which fall next to the ground. This white growth produces the *sclerotia,* which are small, hard black bodies that remain in the soil until next spring and give rise to a new crop of the fungus.

For the control of this disease some very good results have been obtained by sterilizing infected muck soil in greenhouse beds with formaldehyde. Table 1 gives the results of work done this spring.

Table 1

Effect of Formaldehyde as a Control for Damping-Off of Celery

No.	Formalin	Water	Control
	pts.	gals.	
1	3	25	Poor
2	4	25	Poor
3	6	25	Poor
4	3	50	Complete
5	4	50	Complete
6	6	50	Complete

This sterilization was done in a greenhouse which had concrete beds. The soil was slightly moistened before applying the formaldehyde. The applications on the first three plots produced no noticeable control. The amount of water applied was not sufficient to saturate the soil thoroughly. When 25 gallons more of water was applied to these same strengths, making 50 gallons, it was sufficient to saturate the soil, and completely control the organism. It is advisable that care be taken in selecting soil for the greenhouse beds from fields which have not been cropped in lettuce for three or more years. This soil should be sterilized with formaldehyde (3 pints of commercial formalin to 50 gallons of water applied at the rate of 1 gallon to the square foot). Enough water must be applied to saturate the soil. Precaution is necessary to prevent reinfection after the beds are sterilized.

The diseases of celery will be taken up more fully in a bulletin which will be issued within the next year.

REPORT OF SPRAYING TEST AT CAMPBELL'S SOUP FARMS

R. F. POOLE

Spraying for the control of tomato leaf spots and other diseases has already received a good deal of attention by the plant pathology department on the Campbell's Soup Farms, near Riverton. No satisfactory results have as yet been obtained to show any advantage to be gained by spraying, nor to enable this department to recommend a specific spray schedule for tomatoes in the state. The work this year has been a continuation of the work already reported in annual reports from this station by Dr. W. H. Martin, and in Bulletin 345.

Spray applications were made July 9 and August 1 and 14, respectively. Pickings were made September 1 and 13, and October 1, 1920. A rainy season was a factor in preventing higher yields. Table 1 presents some of the results.

Table 1

Results of Tomato Spraying Tests

No.	Treatment	First Picking Sept. 1	Second Picking Sept. 13	Third Picking October 1	Total Yield per Acre
		lbs.	lbs.	lbs.	lbs.
1	Check	568.12	2474.50	429.25	5362.50
2	Bordeaux 4-4-50	1111.00	3181.50	505.00	7406.00
3	Bordeaux 0.5-0-3-50	1237.25	4166.25	404.00	8966.00
4	Check	883.75	3307.75	429.25	7136.60
5	Bordeaux 4-4-50	833.25	4671.25	454.50	9204.00
6	Bordeaux 0.5-0-3-50	580.75	2474.50	479.75	5450.00

This work will be continued. The effects of Bordeaux dust on the control of tomato leaf spots and fruit rots will be given some attention next year.

Other diseases of tomatoes have been reported to this department. The Fusarium wilt has caused a good deal of damage in some fields. The streak disease was very severe during the late summer. Anthracnose was very common on late tomatoes.

INVESTIGATION OF HORSE-RADISH ROOT ROTS

R. F. Poole

The investigation of horse-radish root rots was carried out somewhat in accordance with the work outlined in last year's report. We have learned that the most important problem to be considered in this work is an improvement of storage conditions. The rot organism spreads rapidly in the storage pits, and it is here that the infection is most severe. The temperature and moisture conditions become favorable in the spring for the development of the rots, just previous to planting time. Large roots carried over winter in storage pits for sale are more susceptible to rots than are the smaller roots, stored for seed purposes.

Presence of the Disease in the Field

Several horse-radish farms were visited during the summer and actual counts made of the number of misses in the field. Seed roots in many cases failed to germinate due to rots and this resulted in many misses. Table 1 shows the results of an inspection in August, 1920.

Table 1

Stand of Horse-Radish on Four Farms in August, 1920

Farm	Number of Plants Counted	Number	Misses
			Per cent
1	1835	271	12.9
2	1000	270	21.3
3	2000	126	5.9
4	1305	182	11.7

Less than 1 per cent of the roots which had germinated and were growing became diseased in the field.

Control Tests

Sulfur applied at the rate of 432, 648, 972 and 1080 pounds per acre and hydrated lime applied at the rate of 1080, 2160 and 2700 pounds did not affect the yield in any way. The amount of disease on the areas to which these compounds were applied was small and no disease control due to these mixtures could be estimated.

Roots selected at digging time became diseased very similar to unselected roots, when they were stored in the pits. Careful selection of seed roots in the spring at planting time, and soaking them in corrosive sublimate or formaldehyde solutions showed that the number of misses in the field could be reduced by proper selection and treatment. Table 2 gives the results of the test.

Table 2

Effect of Cutting Horse-Radish Roots to Control Rot

Number	Treatment		Time of treatment	Number of roots soaked	Number	Misses
	Material	Strength	Minutes			Per cent
1	Formaldehyde ..	3 pt. (Commercial formalin) to 50 gal. water	60	364	46	11.5
2	Formaldehyde ..	3 pt. (Commercial formalin) to 50 gal. water	30	743	65	8.0
3	Corrosive Sublimate	1 to 1000...........	20	481	25	4.9
4	Corrosive Sublimate	1 to 1000...........	10	488	33	6.3
5	Selected root	Both ends cut; those showing any discoloration were thrown out	..	1211	99	7.6
6	Check	No treatment	..	1305	182	12.2

The results of this experiment indicate that roots should be carefully selected for planting. Both ends should be cut, and those showing a disease discoloration sorted and thrown out. The selected roots should then be soaked in a corrosive sublimate solution as used above, dried and planted. This work will be continued, and storage conditions will be given more attention.

It is hoped that this work will be sufficiently advanced during the coming year so that it can be published in bulletin form.

INVESTIGATION OF SWEET-POTATO DISEASES

R. F. Poole

Since July, 1920, a very thorough investigation has been made of the sweet-potato disease situation in the state. Inspections were made in order to ascertain the extent of loss due to "stem rot," "black rot," "soil rot," "scurf," and other field diseases, and also to locate severely infested fields of these diseases for experimental work. Storage houses also were inspected in several counties during the winter. These inspections have given us a very good view of the amount of experimental work needed along lines of sweet-potato disease control, both in the field and in the storage house. They have also aided us in locating severely infested areas of the different diseases, which are most suitable for making control tests.

Stem-Rot Control Work

For several years "stem rot" has caused heavy sweet-potato losses in this state, especially in Gloucester County. At digging time in 1919 the county agent of Gloucester County and the writer selected 21 bushels of sweet potatoes by splitting the vines, and throwing out all those that showed discoloration due to the "stem rot" organisms. In the fields where the selection was made, 33 per cent of the sweet-potato vines were infected with stem rot. The potatoes were stored under normal conditions in a storage house at Swedesboro. The selected seed was sorted at bedding time and specimens showing diseases (less than 5/8 bushel) were thrown out. The potatoes were soaked from 8 to 10 minutes in a bichloride of mercury solution (1 to 1000). After soaking they were immediately bedded in a flue-heated hot-bed. Before bedding the potatoes the bed was thoroughly cleaned, salt-hay placed over the flooring, and about 3 inches of clean sandy soil added. After the potatoes were laid in the bed, they were covered with 3 inches of clean soil. The sprouts were grown by John Hunt, a very capable sweet-potato grower at Swedesboro.

On May 26 the sprouts were pulled and equally divided among 5 sweet-potato growers, each getting about 4,000 plants. These plants were kept separated from those grown by the growers, but were planted in the same field in order to get some comparison. Three inspections were made during the summer. The total number of plants and those diseased with stem-rot were counted. Table 1 gives the results.

Table 1

Results of Sweet-Potato Stem Rot Disease Control Experiments in Gloucester County

Experiment No.	Selection	Total Plants Counted July 22	Diseased Plants July 22	Total Plants Counted August 23	Diseased Plants August 23	Diseased Plants September 28
			per cent		per cent	per cent
1	Experiment Station.....	4144	1.88	4144	3.19	5.08
	Grower	1543	2.85	4043	6.30	8.70
2	Experiment Station.....	2819	4.61	2819	4.90	11.20
	Grower	1206	4.47	2814	6.20	14.65
3	Experiment Station.....	2626	3.38	2626	5.20	11.60
	Grower	1170	5.81	2473	6.90	14.00
4	Experiment Station.....	3413	5.27	3413	9.70	20.70
	Grower	1164	4.81	3145	14.70	30.20
5	Experiment Station.....	3389	1.41	3889	1.70	3.60
	Grower	1316	1.36	3947	2.30	3.90
6	No treatment...........	....	....	1100	26.00	51.00

These experiments were made to determine if the stem-rot disease can be reduced. Sweet potatoes actually infected with the "stem rot" were not bedded to compare with those selected. There are sufficient data available to show that heavy infection of "stem rot" occurs when carelessly selected sweet-potato seed is taken from an infected field. This is the result of one year's experimental work. The data given show favorable control results for one season, and the tests will be continued another year along the same line.

There are many climatic and seasonal differences in the counties in which sweet potatoes are grown in this state and there is more "stem rot" in some counties than in others. Sweet potatoes were selected at digging time in several of the other counties, treated and bedded according to the program followed in Gloucester County. This will give us further data on "stem rot" control.

Other Experiments

A very extensive experiment for the control of "soil rot" has been arranged in Gloucester County in cooperation with the extension division and the county board of agriculture. Sulfur, lime, acid phosphate, nitrogen and potash in varying strengths have been applied to an area on which 85 per cent or more of the total roots were infected with soil rot at digging time. The plots are sufficiently large, and should show average results. This experiment covers more than 3 acres and will require a good deal of time.

Inspections at digging time showed that 50 per cent or more of the potatoes harvested in New Jersey were affected with soil stain, also known as "scurf." This disease was very severe when manure and other organic matter were applied in the row or in the hill. Several experiments have been arranged to find out definitely how the disease is disseminated and to study control methods.

Black rot has been severe on some farms. Seed was selected at digging time in the infected fields. Potatoes selected for seed were soaked 10 minutes in a bichloride of mercury solution (1 to 1000) and bedded in a sanitary hot-bed. Close observation will be taken of the spread of the disease in the field.

Up to this time investigations of stem-rot control have been confined to Gloucester County. This year attention is being given to the Fusarium wilt in most of the southern counties at the request of growers from Atlantic, Camden and Burlington counties. Severe cases of black-rot infection have been called to our attention. The practice of selecting seed at digging time, treatment at bedding time and growing sprouts under sanitary conditions, is receiving a good deal of attention.

The results on the control of stem rot are very largely due to the work of Dr. L. L. Harter, of the U. S. Bureau of Plant Industry, and L. A. Cooley, county agent of Gloucester County. The latter has devoted a good deal of attention to the work along with the writer.

STUDIES ON EGGPLANT WILT

C. M. Haenseler

The eggplant growers of southern New Jersey have suffered serious losses for many years due to the eggplant wilt caused by a species of *Verticillium*. Very little experimental work has been done on the eggplant wilt and consequently little is known about this disease except the knowledge gained by observations. There has even been some uncertainty as to the identity of the causal organism.

Some experimental studies were carried out during the spring and summer of 1920 to determine (a) the species of organism causing the eggplant wilt in New Jersey and (b) the time and manner of infection.

A number of collections of wilted eggplants were made in the fall of 1919 and examined for possible wilt organisms. All the plants showing characteristic wilt symptoms revealed the presence of a fungus growth in the vascular tissue when examined microscopically in cross-sections. The fungous hyphæ were noted in the secondary roots, primary roots, the main stem and the secondary branches to within a few inches of the growing tip. No hyphæ were found in the pedicel of the fruit.

Tissue cultures were made from a number of plants, the ordinary precautions being taken to prevent contamination. Pure cultures of *Verticillium albo-atrum* were obtained in almost every case.

Inoculation experiments with the isolated organism were carried out as follows:

The soil in two flats was thoroughly sterilized with formaldehyde (3 pints of formalin to 50 gallons of water) and allowed to dry for 10 days. One of these flats was heavily inoculated with a spore and mycelium suspension of *V. albo-atrum* and the other was left uninoculated. Both flats were seeded with eggplant seed of the American Black Beauty variety. When the seedlings were 5 weeks old they were "spotted" into a transplant bed as would ordinarily be done in farm practice. This transplant bed had been sterilized with formaldehyde and after drying, one-half was inoculated heavily with *V. albo-atrum*. The seedlings from the sterile seed-bed were set into the transplant bed, one-half into the inoculated portion and one-half into the sterile portion. Likewise the seedlings from the inoculated seed-bed were transplanted, part into inoculated and part into the sterile soil.

When the plants were about 4 to 5 inches high they were set into the field on a plot of ground which had not grown eggplants previously. One month after transplanting into the field one-half of the plants were inoculated with *V. albo-atrum* by puncture just below the ground level.

If we designate those plants which were from the inoculated seed-bed by *S,* those from the sterile seed-bed by *s,* those from the inoculated transplant bed by *T,* those from the sterile transplant bed by *t,* those which were puncture-inoculated in the field by *F,* and those which were not puncture-inoculated in the field by *f,* we have the following group of treatments with 10 plants to each group:

stf.	Sterile seed-bed, sterile transplant bed, not puncture-inoculated.
stF.	Sterile seed-bed, sterile transplant bed, puncture inoculated.
Stf.	Inoculated seed-bed, sterile transplant bed, not puncture-inoculated.
StF.	Inoculated seed-bed, sterile transplant bed. puncture-inoculated.
sTf.	Sterile seed-bed, inoculated transplant bed, not puncture-inoculated.
sTF.	Sterile seed-bed, inoculated transplant bed, puncture-inoculated.
STf.	Inoculated seed-bed, inoculated transplant bed, not puncture-inoculated.
STF.	Inoculated seed-bed, inoculated transplant bed, puncture-inoculated.

The plants were carefully observed during the summer for symptoms of wilt. Typical wilt occurred only in a very few plants but the effects of the disease were shown in most of the inoculated plants by a slow growth, small fruit and a premature dying of the oldest leaves. One of the 10 check plants (*stf*) suddenly developed a very severe case of typical wilt between September 10 and 15, but the other 9 plants remained in the prime of condition until frost.

The plants inoculated in the seed-bed only (*Stf*) or in the transplant bed only (*sTf*) were not seriously affected but showed some signs of disease in a number of plants.

The plants inoculated both in the seed-bed and the transplant bed (*STf*) showed slightly more dwarfing and a more rapid dying of the old leaves.

The most severe effects were gotten in the plants puncture-inoculated in the field (*stF, StF, sTF* and *STF*). All of these plants showed severe dwarfing due to the inoculation, and also bore a poor crop and lost the old leaves prematurely. But in spite of these injurious effects there was no typical wilting, the tips remaining in a growing condition until frost. Plants wounded by puncture but not inoculated showed no ill effects whatever.

Table 1 shows the average height of the 10 plants of each group, the measurement being the distance from the ground level to the end of the main branch.

Table 1

Height of Eggplants Receiving Different Treatments

Plant Group	Height	Relative Height
	in.	
stf.	28.7	100.0
stF.	23.7	82.6
Stf.	26.6	92.7
StF.	23.1	80.5
sTf.	27.6	96.2
sTF.	23.7	82.6
STf.	26.2	91.3
STF.	23.7	82.6

Although there are noticeable differences shown in this table, these differences were much more conspicuous in the field, due to the premature dying of the oldest leaves on the diseased plants. There was also a difference in the size of the main stem in the inoculated and the uninoculated plants. For example, the average diameter of the 10 check plants (*stf*), 1 inch above the ground level was 19.2 mm. The ten plants in the adjacent row, which were puncture-inoculated in the field (*stF*) had an average diameter of 14.4 mm., a difference of 4.8 mm. in favor of the uninoculated plants.

Microscopic examinations of every plant in the 8 lots were made to determine whether or not a vascular mycelium could be located. The check plants (*stf*) showed only one plant with a vascular fungus, and with the exception of this plant the wood was healthy and light-colored. Eighty-eight per cent of the inoculated plants showed a darkening of the vascular bundles and 61 per cent of the inoculated plants showed a vascular fungus by microscopic examination. It was noted that a plant which showed a premature dying of the old leaves, a dwarfing of the plant and a darkening of the vascular tissue frequently failed to show the presence of a mycelium in the vessels. This was also noted in material collected in the field. Whether the fungus in these cases had disintegrated or whether it was localized in some part of the plant was not determined. Frequently a badly diseased plant showed only traces of the organism in the vascular system and in such cases it was difficult to account for the wilting on the ground that the water supply had been cut off by the clogging of the tracheary tubes, an explanation that is generally given for the vascular "wilts."

A duplicate of the above test was carried out in another field where eggplants had been grown a few years before. All of the plants in this test developed wilt symptoms, no differences being apparent between the check and the inoculated plants. This was evidently due to the presence of the wilt organism in the field and the infection of the plants after transplanting.

One field observation was made which is worthy of mentioning in connection with these studies. In 1919, Roscoe Bateman, of Grenlöch, N. J., suffered considerable loss from eggplant wilt. In 1920 he planted on "new" land where eggplants had not been grown for many years, if ever. The major part of this new field was manured with manure purchased from the city market but a narrow strip received manure produced on the home farm. The plants grown on the area receiving city manure bore a fine crop of fruit and showed only a very small percentage of wilt, and that late in the season. The plants grown on the area receiving the home-made manure, on the other hand, failed to make a good growth and produced practically no marketable fruits. All these plants were affected by the wilt disease as was shown by the dwarfed condition, the darkening of the vascular tissue and the premature dying of the old leaves.

It seems evident that in this case the disease was carried in the manure. Although such observational evidence is not convincing, yet it should be taken as a caution against using manures which are liable to contain the wilt organism.

A test was made to determine whether or not seed taken from the fruit of wilted plants carries the wilt organism. Two ripe fruits were collected from plants which by external symptoms and by microscopic and cultural tests proved to be badly affected with *Verticillium* wilt. These fruits were surface-sterilized and cut open with a sterile knife. Five seeds from each of the fruits were plucked out with sterile forceps and placed into flasks containing nutrient agar, one seed being placed in each flask. Five other seeds were taken from each of the fruits and cut into halves and put into flasks of agar. These twenty cultures were incubated for 30 days at 29°C. Three of the flasks developed bacterial contamination but no fungus developed in any of the cultures. This test would indicate that the wilt organism does not advance into the seed of fruits borne on badly diseased vines.

Attempts to infect tomato and pepper plants with the *Verticillium* taken from wilted eggplants gave negative results.

PRAYING EXPERIMENT FOR THE CONTROL OF PEAR FRUIT AND LEAF SPOT

C. M. HAENSELER

A spraying experiment was conducted in the spring of 1920 in a pear orchard owned by the Minch Bros., Bridgeton, N. J., to determine the relative efficiency of various spray mixtures in controlling the pear fruit and leaf spot caused by *Fabræa maculata*. The orchard was blocked off into five plots of about 30 to 40 trees each, and the plots sprayed as follows:

Plot 1.	Check—no spray.
Plot 2.	Commercial concentrated lime-sulfur; 1 gallon to 40 gallons of water.
Plot 3.	Bordeaux mixture, 3-4-50.
Plot 4.	Self-boiled lime-sulfur, 8-8-50.
Plot 5.	Pyrox.

Three pounds of dry arsenate of lead per 100 gallons of spray was added to each of the mixtures except the Pyrox. Four spray applications were made; on May 17, May 27, June 9 and July 30, respectively.

During the summer the unsprayed plot developed considerable fruit and leaf spot and an examination made on September 22 showed that many of the unsprayed trees had lost one-half or more of their leaves as a result of the disease.

The commercial lime-sulfur, Bordeaux mixture, and Pyrox all gave a complete control of the fruit and leaf spot, but these mixtures caused more or less spray injury to the pear fruit. Although this spray injury did not affect the yield it was sufficient to mar the general appearance and consequently decrease the market value of the fruit.

On the self-boiled lime-sulfur plot a small amount of disease developed but the attack was not severe enough to cause any appreciable damage. The fruit on this plot did not show any signs of spray injury and was much smoother and better in general appearance than that from any of the other plots. Since the self-boiled lime-sulfur gave a practical control of the disease, and at the same time left the fruit in such perfect market condition, it may be concluded that the self-boiled lime-sulfur gave slightly better results in this experiment than did the other three spray mixtures.

This experiment was planned to compare the relative value of various spray mixtures in controlling the pear fruit and leaf spot and not to work out a complete spray calendar for this disease. The number of applications necessary to insure a complete control and the best time to apply these is still a problem to be solved, and will be taken up during the coming year.

Until a complete spray schedule has been experimentally worked out it will doubtless be best to use a schedule similar to that used so successfully in the above tests. From these tests we know that good results may be expected from four applications of self-boiled lime-sulfur, beginning about 10 days after petal fall, giving the first three sprays at 10 to 14-day intervals and the fourth spray about 3 weeks after the third. This treatment should give clean, smooth fruit and leave the trees in a vigorous condition to produce strong healthy fruiting spurs for the following year's crop.

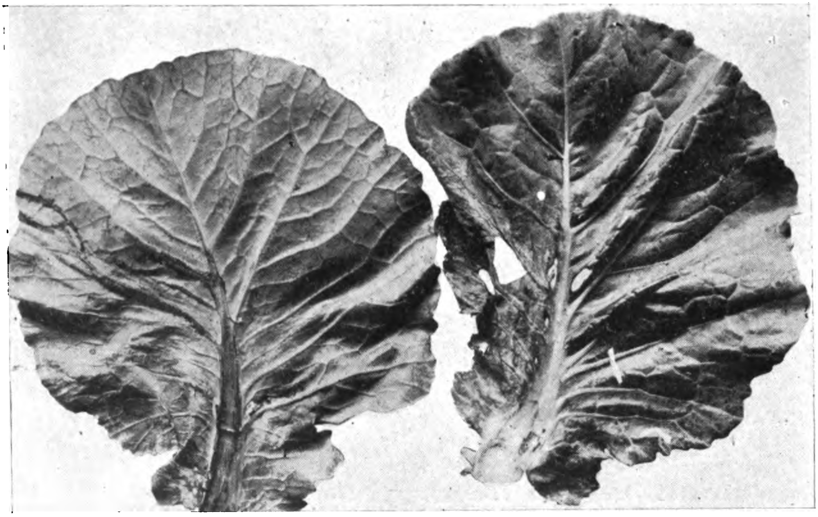

FIG. 1. BLACK ROT, A BACTERIAL DISEASE OF CABBAGE. NOTE DARKENING OF VEINS DUE TO ATTACK OF ORGANISM. *Bacterium campestris.*

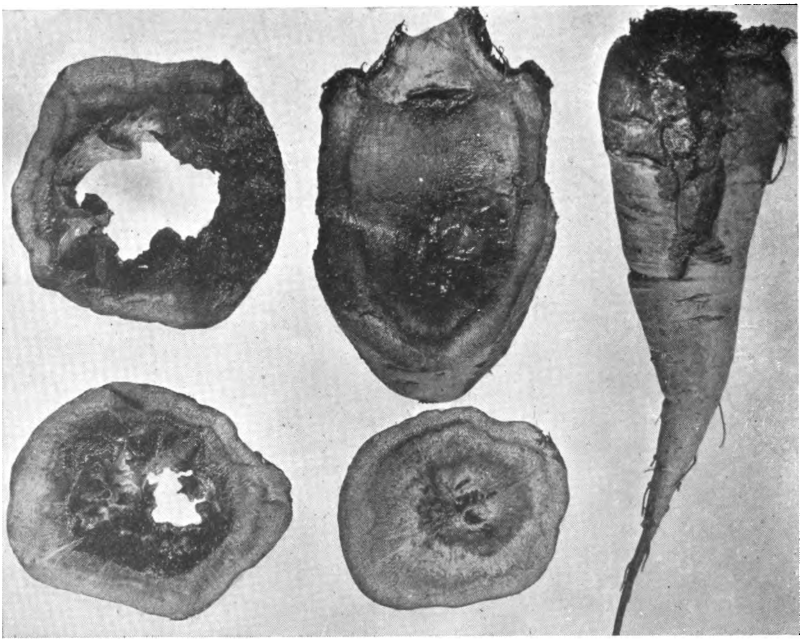

FIG. 2. BACTERIAL SOFT ROT OF CARROT, DUE TO *Bacillus carotovorus* JONES.

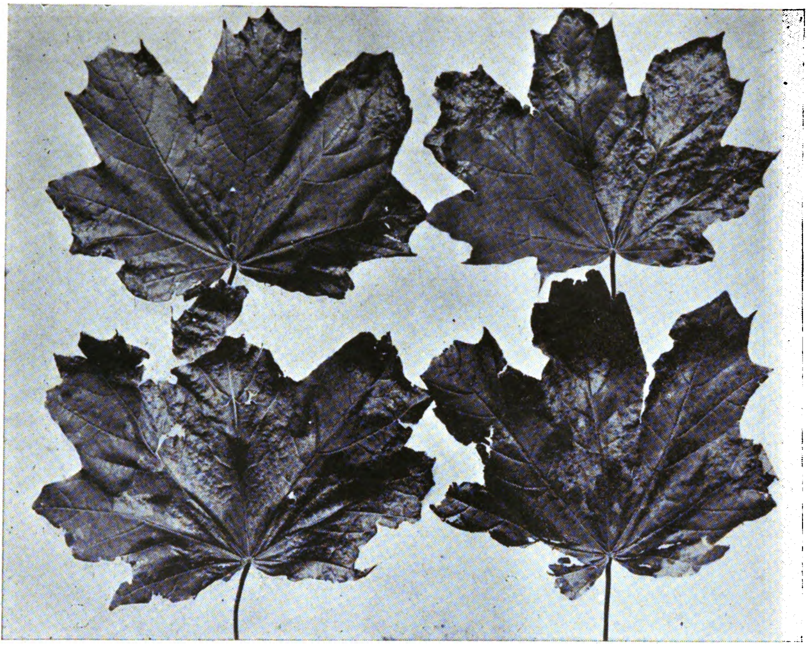

FIG. 1. LEAF SCORCH OF MAPLE.

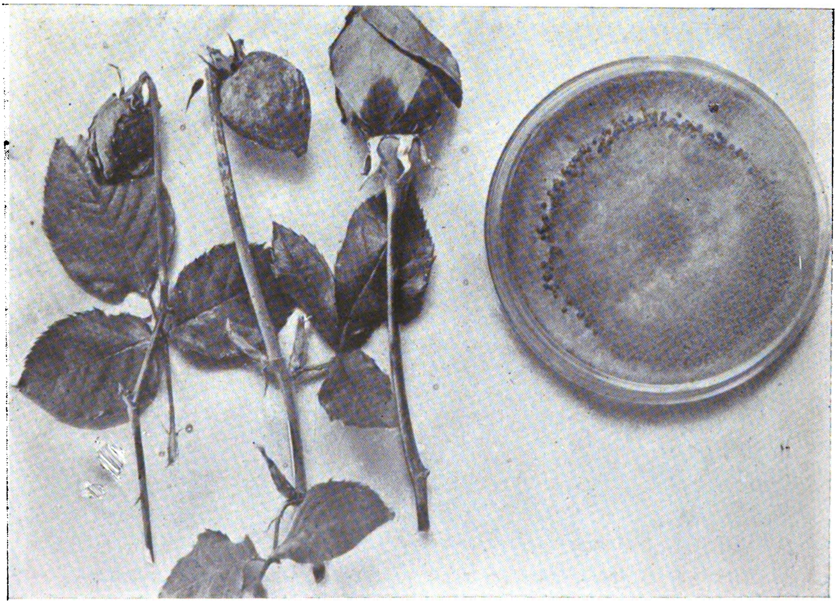

FIG. 2. BUD ROT OF ROSES. *Botrytis* sp.

PLATE 3

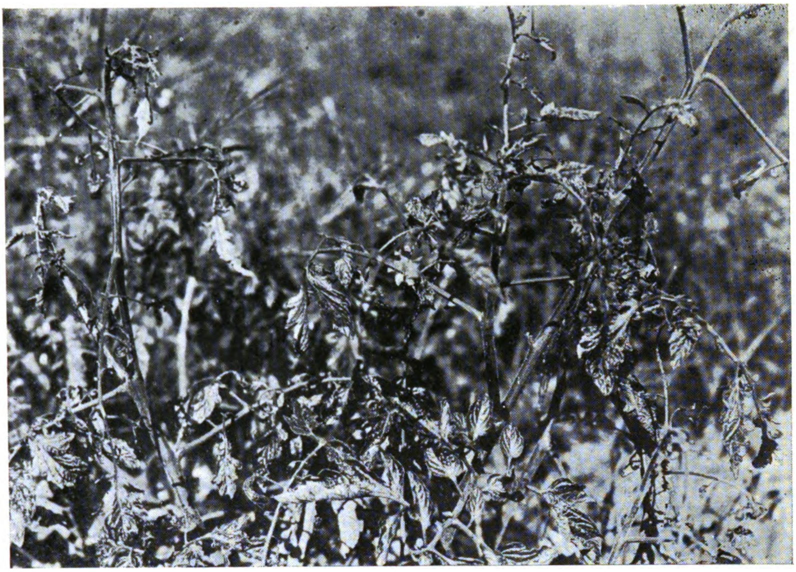

FIG. 1. THE STREAK DISEASE OF TOMATO.

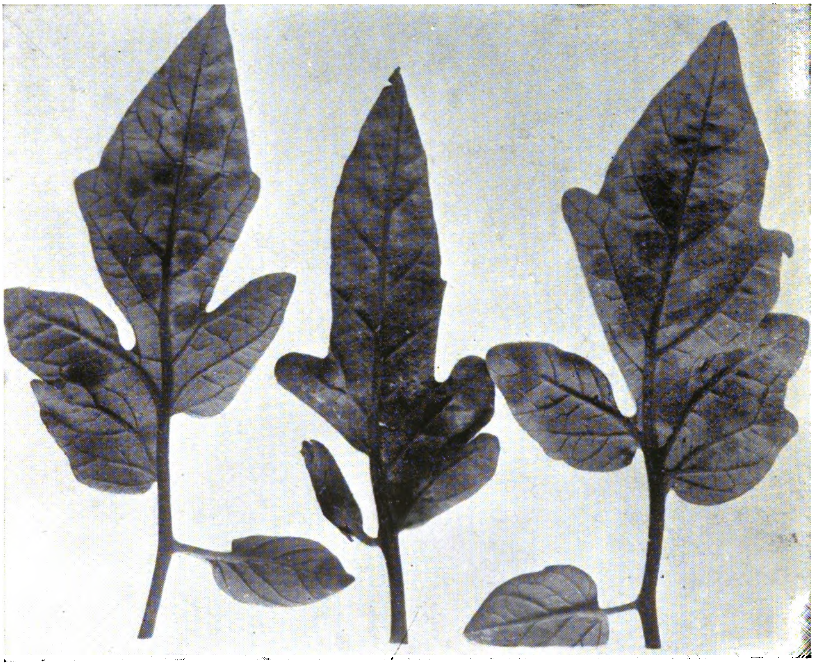

FIG. 2. LEAF MOLD OF TOMATO. *Cladosporium fulvum.*

FOLIAGE INJURIES

MEL. T. COOK

During the spring and early summer of 1921 we had an exceptionally large number of inquiries concerning the scalding and falling of the foliage of trees. Most of these inquiries were concerning the foliage of sugar maple, Norway maple and beech, but some inquiries were made in regard to apple and cherry.

In this connection we must again call attention to warm weather in the early spring followed by frosts which destroyed the greater part of the peach and cherry crop and very greatly reduced the apple crop. The frost came when the young foliage was very susceptible to injury and the effects were noticeable on forest, shade and fruit trees. Furthermore, many leaves that did not show injury at that time fell in great abundance later in the season. This was very frequently confused with falling due to other causes. The greatest confusion was in regard to the cherry in which the falling was partly due to the early frost and partly to the leaf spot fungus *Cylindrosporium padi.*

The leaf-scald of the shade trees was due primarily to the lack of both water and food. City drainage is planned to get rid of the water as rapidly as possible, which makes it impossible for any considerable amount to penetrate the soil. Furthermore, the soil surface is reduced by the pavements. Since trees cannot get the mineral foods of the soil without water, they suffer for want of both water and food. The transpiration is increased by the reflected heat from the pavements and buildings. The result is the scalding or the falling of the foliage, and in some cases both.

This can be controlled to some extent by pruning out 25 per cent or more of the branches in the fall, by giving good applications of fertilizers in the spring and by loosening the soil around the trees so as to permit the water to enter the soil.

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